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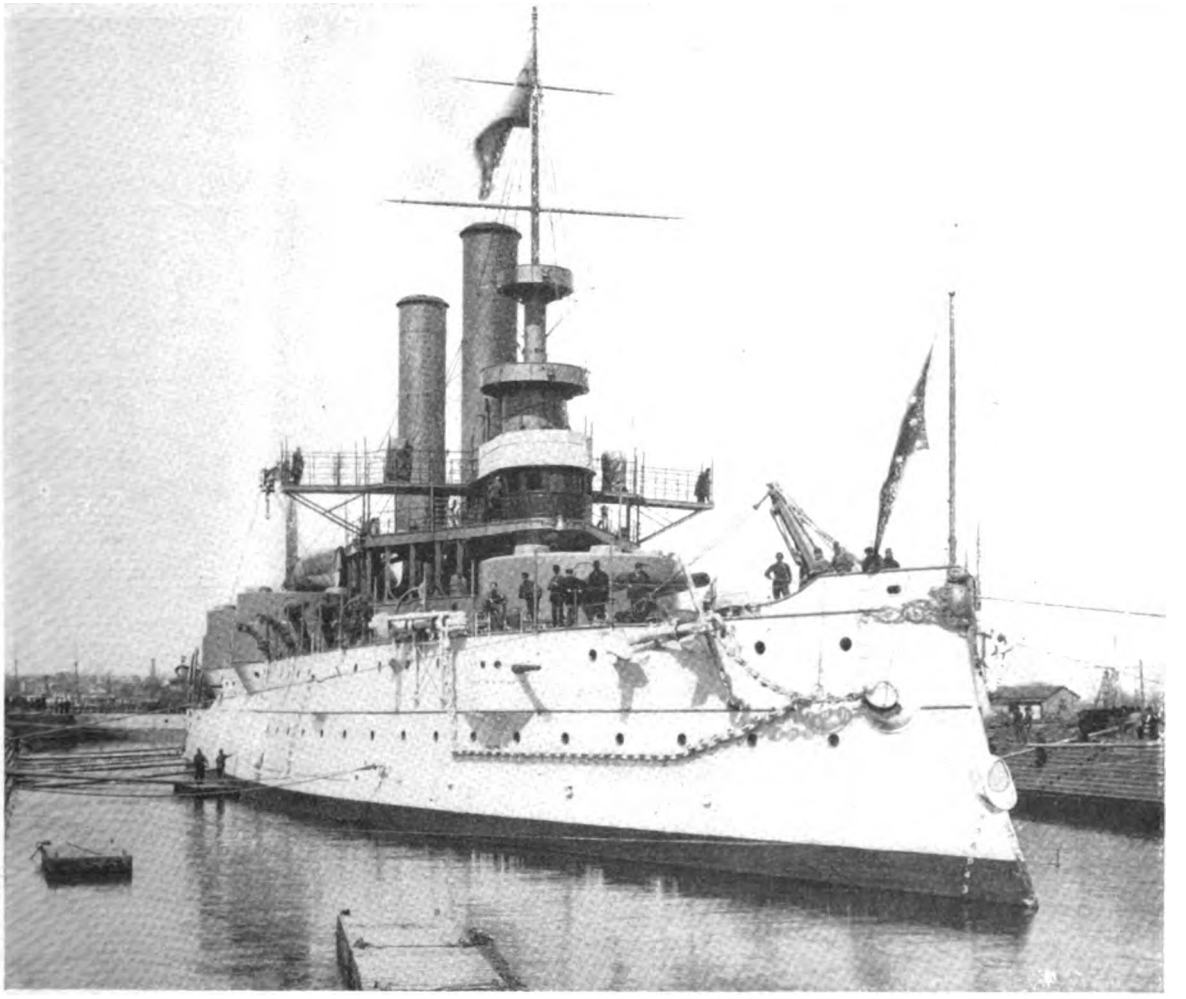
U. S. SEA-GOING BATTLESHIP IOWA, BUILT BY W. CRAMP & SONS.

The finest war vessel in the American Navy and as fine a ship as ever flew a naval flag is shown in the illustration of U. S. seagoing battleship Iowa, on this page. The fourth battleship of the new navy, the Iowa, embodies many novel features and improvements over the design of those previously built—the Indiana, Massachusetts, and the Oregon. The appropriation by Congress for the construction was approved July 19, 1892, and the work was awarded William Cramp & Sons, of Philadelphia, on February 11, 1893, at the contract price of $3,010,000. On August 5, following, her keel was laid; on March 26, 1896, she was launched, and on April 7, 1897, she went on her trial trip off the Massachusetts coast. The general dimensions which are here given are supplemented by a list of similar dimensions of the



U. S. BATTLESHIP IOWA, IN DOCK AT NAVY YARD, N. Y.

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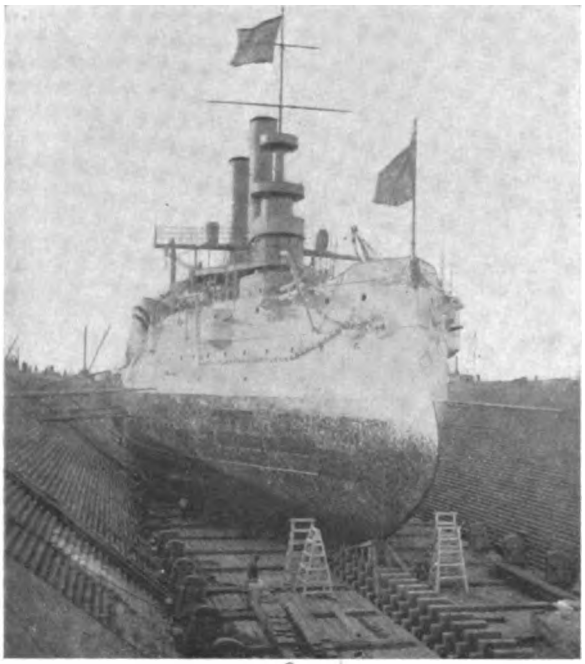
battleship Indiana, which shows wherein the Iowa excels the earlier battleships:



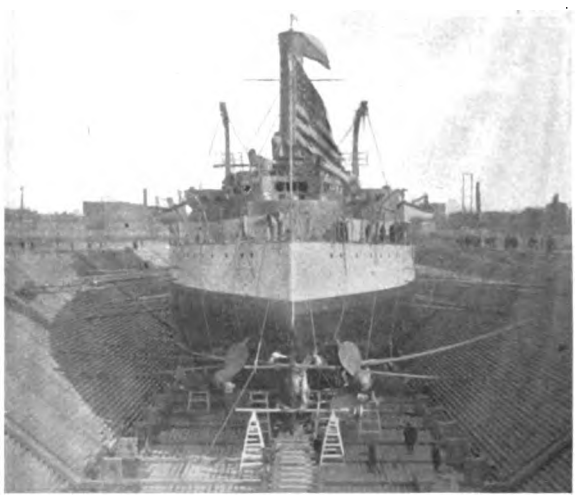
IN DRY-DOCK, SHOWING RAM.

Dimensions.	Iowa.	Indiana.
Length on load water line	360 ft.	348 ft.
Breadth of beam, extreme	72 ft. 2½ in.	69 ft. 3 in.
Displacement in tons, normal draught	11,410	10,288
Mean draught at normal displacement	24 ft.	24 ft.
Freeboard forward	19 ft.	11 ft. 7½ in.
Normal coal supply	625 tons.	400 tons.
Total coal capacity	1,780 tons.	1,640 tons.
Maximum indicated horse-power	11,000	9,000
Speed in knots, contract	16	15
Complement of officers and crew	486	460

The Iowa is built of mild steel, with a double bottom, and water-tight bulkheads extending up to a height of 10 ft. above the load water line. The defensive powers of the vessel are provided for by a belt of 14 in. steel armor 7½ ft. wide, extending along the water line region a distance of 185 ft. 6 in. amidships. This is 3 ft. above and 4½ ft. below the water line. The forward and after ends of the belt turn inboard and run diagonally across the ship, with a thickness of 12 in. Within the bounds of this plating and on the level with its upper edge a flat protective deck of 2¾ in. steel is in place. Inside this protected portion of the hull are carried the propelling machinery and the magazines. The inboard ends of the side armor form the foundations for the barbette turrets. Protection for the unarmored ends is secured by an extension of the midship protective deck, fore and aft, to the stem and stern. These decks, which are 3 in. thick, start from the lower edges of the diagonal armor and extend the width of the ship. The forward deck terminates back of the ram, giving a very useful stiffening here. From the upper edge of the 14 in. armor belt there rises 4 in. of hardened steel, for a distance of 90 ft. amidships, backed by a belt of coal several feet in thickness. Forward and abaft the casement armor, from the protective deck to the main deck, the skin is backed by a wide cofferdam filled with cellulose, and minutely subdivided. This is expected to keep out any appreciable quantity of water should the sides be pierced in action.

The formation of the sides amidships, where they curve inboard, secures the necessary freeboard without the added weight consequent were the lines carried up with the water line fulness. The weight of material saved here was utilized in carrying the sides higher forward. Thus an easier curve of stability, roomier quarters for the crew, greater sweep of the guns in the broadside sponsons, and the probability of increased efficiency of the great guns, in almost any fighting condition of the sea, was secured.

The main battery consists of four 12 in. and eight 8 in. breech loaders. These are mounted in pairs, the former in two Hichborn barbette turrets, of the balanced type. The 12 in. guns can fire through an arc of 270 deg. Their turrets are 15 in. thick, while the barbettes, which extend down to the protective deck, are 17 in. thick. The advantage of the balanced turrets in wide angle fire is apparent. In the Indiana, for example, the main battery is fitted in unbalanced turrets, and when trained in a broadside direction produces a considerable heeling effect. The 8 in. rifles are



IN DRY-DOCK, SHOWING PROPELLERS.

mounted on the upper deck in four barbette turrets, of the ordinary type, 8 in. thick. They fire through an arc of 160 deg.

The secondary battery is composed of six 4 in. rapid fire rifles, four of which are mounted on the

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main deck in armored sponsons, and sheltered by thick splinter bulkheads of steel, and two are mounted aft on the bridge deck, sheltered by fixed shields. Twenty 6-pounder, four 1-pounder, and four Gatling guns constitute an auxiliary force, and are mounted on the main deck, on the upper deck, and bridges, and in the tops of the military mast. The ship is also fitted with five torpedo tubes, one in the stern and two in each broadside.

As the Iowa is fitted with twin screws, the propelling machinery consists of two sets of triple expansion engines, fitted in separate water-tight compartments. The cylinders are 39 in., 55 in. and 85 in. dia. by 48 in. stroke. Steam boiler pressure of 160 pounds is generated in three double-ended boilers, 16 ft. 9 in. dia., one 20 ft. long, and two 19 ft. long; and two single-ended, 16 ft. 9 in. dia. and 9 ft. 10½ in. long. These are fitted in four water-tight compartments. Forced draught is used at the higher speeds. On the trial trip the Iowa, on a mean draught of 24 ft., showed a mean speed of a fraction less than 17 knots, the engine making between 110 and 112 revolutions. At full speed the ship has a radius of endurance of 5 days, in which 2,213 miles could be run. At the cruising speed of 10 knots, the bunker capacity would carry her 8,022 miles.

Nearly a hundred auxiliary engines are used to operate the hydraulic, electric and other apparatus for turning the turrets, working and loading the guns, lifting and lowering the boats, raising the anchors, controlling the rudder, bringing up the ammunition from the magazines, providing fresh water, lighting the ship, making ice, preserving the fresh food, and thoroughly ventilating the ship by powerful blowers. In the construction the use of wood has been dispensed with wherever possible, and that which is absolutely necessary has been subject to an electrical fire proofing process. In the matter of fittings, to secure comfort for the officers and crew, this ship does not differ materially from the coast line battleships, save in one particular, and that an important one, the additional accommodation for the crew afforded by the forecastle deck. This is a very valuable feature, particularly in tropical climates or when the ship's company may be augmented by the presence of prisoners or rescued seamen.

The total number of ships under construction for the British Navy for the year 1897-98, commencing April 1, is 108. This includes fourteen battleships, eight first-class cruisers, nine second-class cruisers, ten third-class cruisers, two sloops, four twin-screw gunboats, fifty-two torpedo-boat destroyers, eight light-draught steamers and one Royal yacht. The total displacement tonnage is 38,000 tons and the aggregate horse-power about 800,000 indicated.

The French Government has let contracts for three torpedo boats, each to have a speed of 24 knots, and to cost $63,380.

HINTS ON ELEMENTARY STABILITY, WITH REMARKS ON WATER BALLAST.*

BY CAPT. A. S. THOMSON, LIEUT. R. N. R.

Actual statical stability, is defined as the moment of force of which a floating body endeavors to regain a position of stable equilibrium after having been deflected from it. The center of buoyancy may be considered the point of support for a floating body, and so long as this point is above the center of gravity a vessel will have stability at all angles of inclination; moreover, this stability, as in the case of a body having rigid support, is quite independent of form. In the case of a solidly supported body, the vertical through the center of gravity must not fall outside the base, whilst for the floating vessel it must not fall outside the point to which the center of buoyancy moves out as the vessel heels. Thus the distance to which the center of buoyancy moves out on either side of the center of gravity, for a single angle of heel, may be compared to the length of rigid base of a body having solid support, outside which supporting base the vertical through the center of gravity may not fall if stability is to be retained.

In order to illustrate the transverse stability, it is convenient to take a section of a vessel in a plane at right angles to the keel. Such a section can be drawn to represent, both in form and area, the resultant value of a number of similar sections taken at equal intervals throughout the length of the ship. A simple plan to find the required approximate area is to take the transverse sectional area of the actual ship at the widest part, and multiply it into the known co-efficient of fineness, the form of the required section being readily found by referring to the half-body plan. Keeping in mind that, in a transverse plane, every longitudinal axis appears at a point, and every longitudinal plane as a line, the transverse stability of the section may be taken as fairly representing that of the entire vessel. The line, vertical in the upright position, dividing the section into two equal and symmetrical parts, we shall now call the middle line.

The apparent weight of the ship as a whole may be considered to act downwards through the center of gravity, whilst an equal and opposite force reacts upwards through the center of buoyancy. For a vessel to float freely at rest in any given position, these two points must be in the same vertical line. When they are not so situated, the equal and opposite forces acting through them form a couple, and the vessel, if left to herself, rotates till the couple disappears and equilibrium is restored. The center of buoyancy moves out from the middle line as the vessel inclines, its position depending solely on the form of the displacement, and being quite unaffected by mere change of volume of displacement. The center

* From a paper read before the Shipmasters' Society, London, on March 25, 1897.

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of gravity tends to move vertically, such motion being necessary to maintain the volume of displacement constant at all angles of inclination.

The center of gravity tending to move only vertically, it is usual to consider it as the point about which the transverse section may be supposed to rotate. The measure of stability for any given angle of heel is the righting moment of buoyancy which then obtains. This righting moment, generally expressed in foot tons, is equal to the weight of water displaced by the ship multiplied into the horizontal distance in feet between the verticals through the centers of gravity and buoyancy respectively.

As a vessel heels a wedge-shaped portion of the hull becomes immersed, whilst a more or less similar wedge, having precisely equal volume, rises out of the water on the opposite side, the total displacement of course remaining the same as before the inclination took place. As long as similarity in the form of the in-and-out wedges is retained, the center of buoyancy moves out along the arc of a circle, the center of which is the metacenter, the moment of buoyancy increasing as the side of the angle of heel. In the majority of cases this condition only holds good for small inclinations of about 10 degrees, for, as the inclination continues, want of parallelism in the vessel's sides above and below the water line generally causes increasing dissimilarity of the in-and-out triangles. The center of buoyancy now commences to have a curve of varying radius, the centers of which are called prometacenters. These points are located by the intersection of successive verticals through the center of buoyancy at different angles of heel. The metacenter, as its name is supposed to imply, is the limit of height to which the center of gravity may be raised without destroying stability for small inclinations. Good breadth of beam combined with small displacement gives maximum metacentric height for a given position of center of gravity, and consequently greatest initial stability. Unless, however, the center of gravity is low relatively to the metacenter, the stability will be of small amount. Under all circumstances lowering the center of gravity increases stability, so that even a deep narrow ship with weights kept low down in the hull, will have great stability at large angles of inclination. A vessel with good initial stability is said to be stiff, and one deficient in this respect tender, yet at large angles of inclination, the tender vessel may have greater stability than the wider and shallower craft.

A ship when oscillating behaves as a pendulum and also as a balance wheel of a watch, but principally as the latter. Inasmuch as the center of gravity tends to move vertically the ship behaves as a pendulum; inasmuch as the whole mass of the ship tends to rotate about an axis more or less coincident with the center of gravity, she behaves as a balance wheel. The period of a compound pendulum depends on the length alone of the equivalent simple pendulum, but the period of a balance wheel depends on its moment of inertia and the strength of the controlling spring. The height of the center of buoyancy above the keel is readily found for any vessel when upright by referring to the displacement scale—note, the mean draught, taking the corresponding displacement from the scale—then the draught which gives half this displacement is the height of the center of buoyancy above the keel. The position thus determined should coincide with the center of area of any transverse section which may be intended as a guide to the stability of the same vessel. Should the points not coincide, the under-water part of the section should be altered until coincidence results.

The metacentric height, a distance between metacenter and center of gravity in the upright position, may be determined by a very simple experiment. The position of one of the limiting points being known, that of the other follows. The ship, being perfectly upright and floating quite freely, is slightly listed, usually by moving a known weight across the deck. The displacement must be accurately known, and the angle of inclination carefully measured by means of a long plumb line, or when this is not possible, by the use of a delicate clinometer. What has now taken place is this: the center of gravity and center of buoyancy have both moved towards the side to which the ship inclines, and the vertical through both points makes a known angle with the middle line at the metacenter. The direction in which the center of gravity has moved coincides with the direction in which the known weight was moved, and the distance through which it has moved is of course the product of the known weight into the distance moved, divided by the total sectional displacement.

A vessel when oscillating behaves in many respects like the balance wheel of a watch. For simplicity, we will take a section of a ship so loaded that the center of gravity is in the plane of flotation, and this being so we may assume the ship to oscillate about her center of gravity. Now, if the ship under these circumstances has a period, that period cannot be due to pendulum action, for the center of gravity does not raise or fall to any appreciable extent. If the vessel is inclined and then allowed to oscillate freely, the moment of buoyancy will act as the spring of a balance wheel, causing the ship to regain an upright position, at which instant the force of the spring will be zero. Inertia will then continue the swing past the upright or central position till the moment of inertia is overcome by that of buoyancy or the compression of the spring, when the swing will be repeated in the opposite direction. Now, the moment of buoyancy in different vessels for a given inclination and length of righting arm varies as the weight of the vessel, but the moment of inertia in different vessels varies as the product of the mass of the ship into the square of the radius

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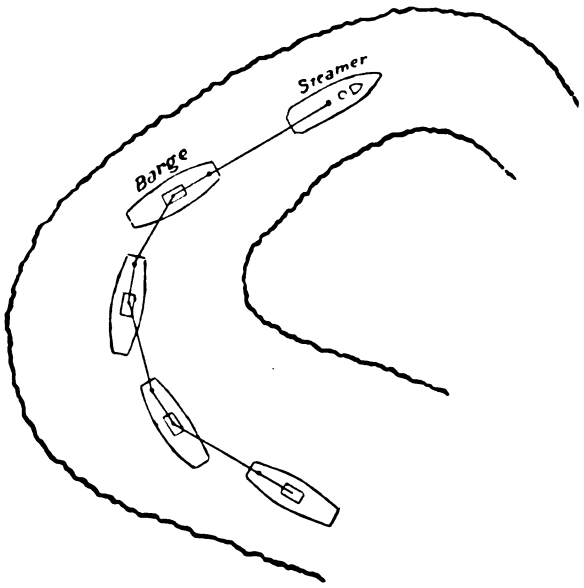
of gyration, or distance of the center of gyration from the center of gravity. Weight for weight, then, the larger a ship the longer the period; and size for size, the longer the radius of gyration, the longer the period. It cannot be too strongly insisted on, that some degree of reserve or excess stability is necessary for the safety of a vessel in a sea-way; at the same time, we must be on our guard against exaggerated theories which seem to require the length of righting lever practically doubled in order to guard against disaster under not unusual conditions.

With regard to the carriage of water ballast, nearly all steam vessels and some of the more modern sailing ships are fitted to carry water ballast either in shallow double bottoms more or less continuous over a great portion of the length of the vessel, or in deeper tanks of lesser longitudinal extent. In nearly every case, however, the capacity of these tanks is small compared with the tonnage of the vessel, water ballast being intended originally partly for trimming purposes and partly to enable the ship to stand upright when empty, or, again, in the case of steamers, to retain stability, which is affected by consumption of fuel. Ships are nowadays frequently sent to sea, even to cross the Atlantic in winter months, depending almost entirely on water ballast. In many instances the quantity of water carried is scarcely sufficient to ensure seaworthiness, and, even when this is not the case, it only too often proves a source of danger and discomfort through being carried so low down in the vessel. Notwithstanding that the ship is like a cork on the water, with propeller half immersed, and scarcely able to face a heavy head sea, the metacenter height may be considerable enough to give rise to violent lurching, or abnormally heavy rolling in certain conditions of wind and sea. Water being the most economical and convenient form of ballast, the remedy seems to be in the devising of some simple and not too costly arrangement whereby ships may carry a much greater quantity of water, distributed in a manner better adapted to the requirements of stability and easy motion in a sea-way. Captain Froud suggests the simple plan for sailing vessels of dividing the main hold into two or more compartments by means or transverse bulkheads, and filling them completely with water up to the level of the steel upper deck. For steamships it would seem that deep wing tanks, which might also be used as bunkers for coal in addition to the ordinary double-bottom tanks, would best suit the necessities of the case.

Californian Method of Towing Barges.

The sketches here presented show the method of towing on the Sacramento and San Joaquin Rivers in California. The towboat is fitted with a tow post which is almost as high as the stack. From this the line, which is invariably of wire rope, is carried to the first barge and secured to



TOWING BARGES AROUND BEND.

the forward bitts in the usual way. Each barge is fitted with a towing frame of five vertical posts connected by a steel bar. This extends the entire length fore and aft, and is carried over the pilot house. When more than one barge is being towed the line is carried from the centre tow post on each barge to the bitts on the barge astern. The object of this system is to operate the towboat and barges independently, so as to speedily navigate the winding and shallow streams, and to dodge snags, sand bars, cobblestone bars, and shoal places. The barges used in the river above Sacramento have a capacity of 330 tons of grain, which they carry on a draught of 22 to 24 in. The barges used below Sacramento are of larger capacity, carrying 800 tons. Besides grain, the traffic on the Sacramento River in these vessels, consists largely of lumber, bricks, fruits, and vegetables. In the crooked portions of the river a speed of about 10 miles an hour is maintained, but in open water this is considerably increased. The principal route on the Sacramento River is from San Francisco to Red Bluff in Tehama County, a distance of 275 miles. Most freight is taken to the coast from Sacramento City.

CALIFORNIAN METHOD OF TOWING ON SACRAMENTO RIVER.

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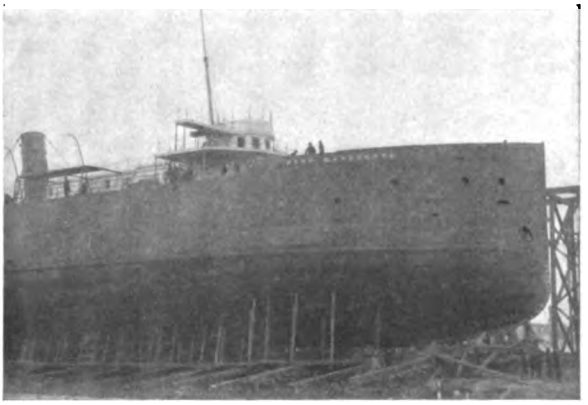
LARGEST SEA-GOING FERRY IN EXISTENCE.

The steel twin screw car ferry, Pere Marquette, recently built by Messrs. F. W. Wheeler & Co., of West Bay City, Michigan, for the Flint and Pere Marquette Railroad Company, to be used



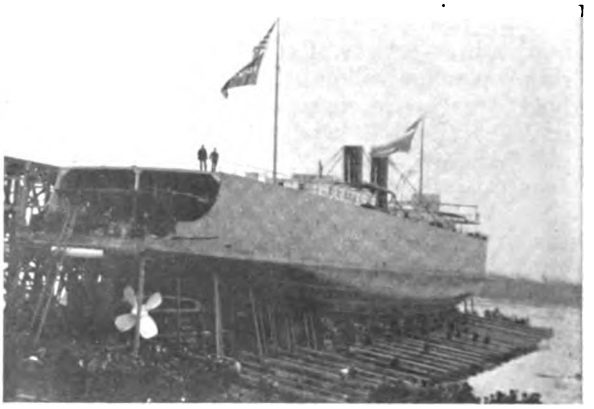
PERE MARQUETTE ON THE STOCKS.

in the transportation of freight or passenger cars across Lake Michigan, is by far the largest and most complete vessel of its class in the world, and marks an era in car ferry construction. This vessel is 350 ft. in length, over all; 338 ft. between perpendiculars; with a beam of 56 ft., and depth from keel to upper deck of 36 ft. 3 in. The moulded depth to main deck is 19 ft. 6 in. There are four tracks with a capacity of 30 freight cars, and when fully loaded the ferry has a displacement of 4,050 tons, on a 12 ft. 3 in. draft of water.

Being intended for both summer and winter service, with the certainty of encountering very heavy ice, and severe gales from four to five months in the year, the first consideration was great strength combined with the most approved shape of hull, to resist the tremendous crushing strains which would undoubtedly at times be brought to bear. In view of this the framing from below the turn of the bilge to the upper deck is of channel section 12 in. deep and weighs 25 lbs. per ft. These frames are spaced 24 in. apart, with every alternate frame stopping at the under side of the main deck stringer plate. The keel is of the flat plate type, and is 48 in. in width, and weighs 32½ lbs. per sq. ft. To this is connected by heavy angles the vertical, center-plate keelson, 42 in. wide, and 25 lbs. per sq. ft. in weight. The floor plates are 30 in. deep at the center by 20 lbs., and are connected to the center girder by double angles. A foundation plate is securely riveted to the top of the floors and connected to the center girder by 12 in. channels, on top of which is a rider plate the width of the two flanges of the channels and the thickness of the center keelson plate. The frames connecting the floor plates to the shell plating are of angle steel, and extend from the center of the ship to the lower turn of the bilge, there butting against the channel side frames. The side frames extend far enough below the bilge to make a strong connection with the floors.

On each side of the center girder, and spaced about 6 ft. 9 in. apart, are 2 continuous keelsons, consisting of intercostal plates, flanged to the shell plating and extending above the top of the floors, sufficient to be riveted between double bulb angles on the one nearest to the center, and double channels on the other. Everything pertaining to the bottom construction of the vessel in the engine and boiler spaces is made extra heavy. At the lower turn of the bilge, and connected to the reverse bars on top of the floors is a heavy keelson formed of double 9 in. channels, riveted back to back. The bilge keelson consists of intercostal plates flanged to the shell and riveted between double bulb angles, which are securely connected to the main frames. The shell plating from keel to bilge is 25½ lbs. per sq. ft. in weight. Above the bilge there are 2 water-line strakes, and the main sheer strake, which is doubed, all of 30 lbs. per sq. ft. The shell plating between the main and upper decks is 10 lbs. and 12½ lbs., the upper deck sheer strake being 15 lbs. For about 35 ft. abaft the stem, and from the keel to about 3 ft. above the water line, the shell plating is double. Inside the vessel at this point is a network of heavy diagonal braces, keelsons, beams and brackets.

A special feature in the Pere Marquette is that the propellor shafts are entirely enclosed within the hull, the vessels framing being so shaped as to form a sleeve for the shafting. At the extreme ends of these tubes, or sleeves, heavy cast steel brackets are fitted, moulded to the shape of the vessel. These brackets are riveted together at the center of ship, an intercostal plate extending between frames, being first fitted between them. At the water line there is worked a continuous plate stringer 49 in. wide, securely connected to the shell and main frames with



READY FOR LAUNCHING.

heavy angles. This stringer is bracketed above and below to the main frames with large plate brackets. Channel beams 12 in. deep, spaced

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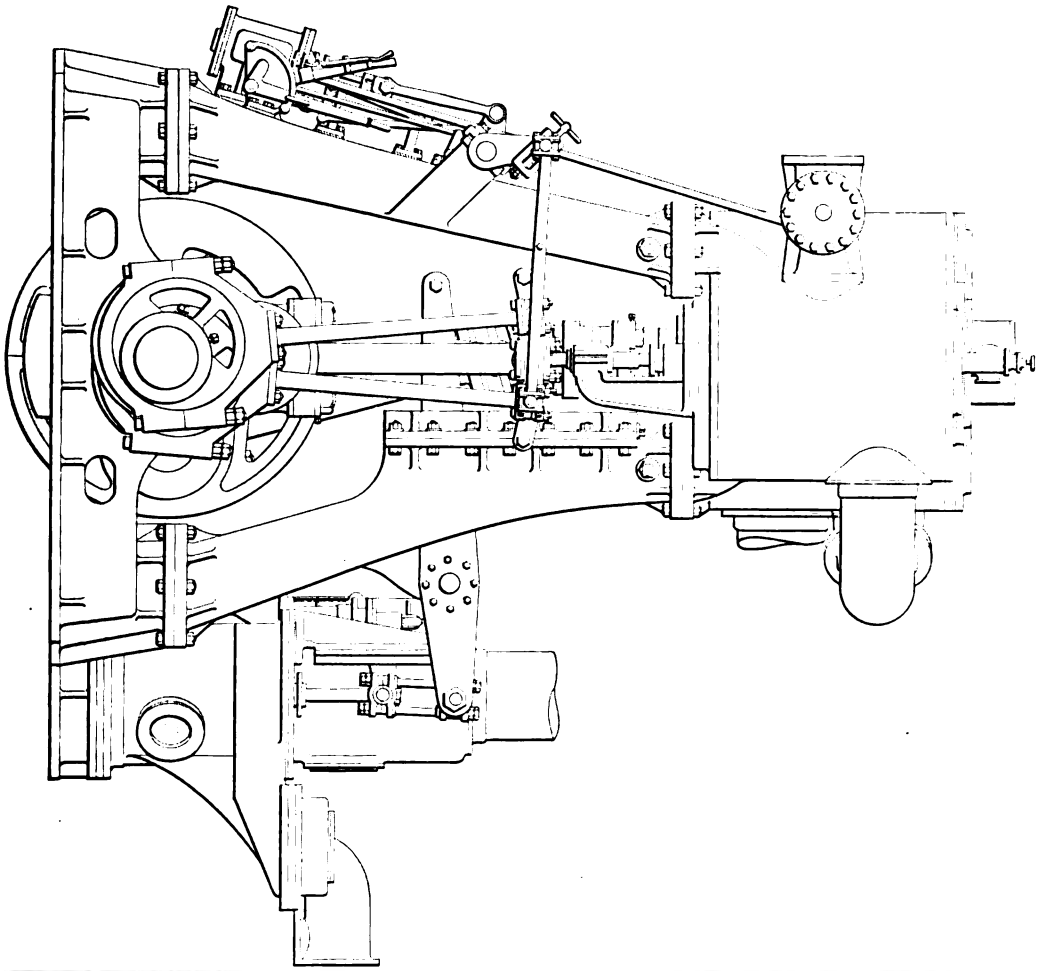

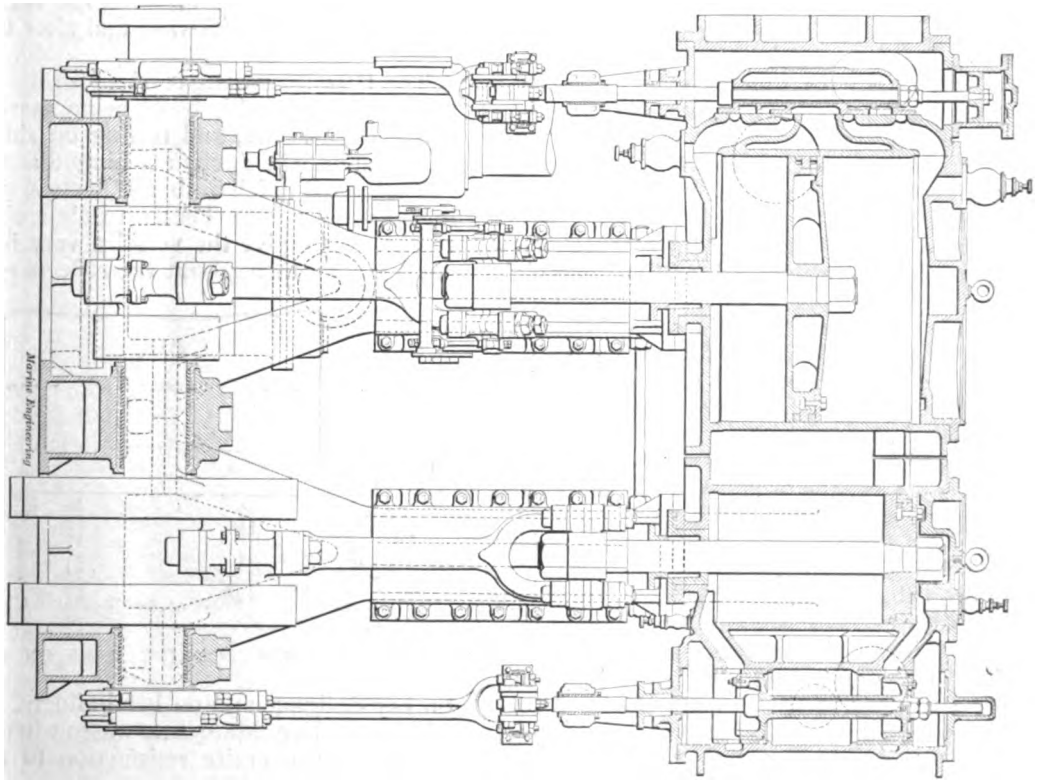

TWIN-SCREW COMPOUND ENGINES FOR SEA-GOING FERRYBOAT PERE MARQUETTE.

CONSTRUCTED BY F. W. WHEELER & CO., WEST BAY CITY, MICH., U. S. A.

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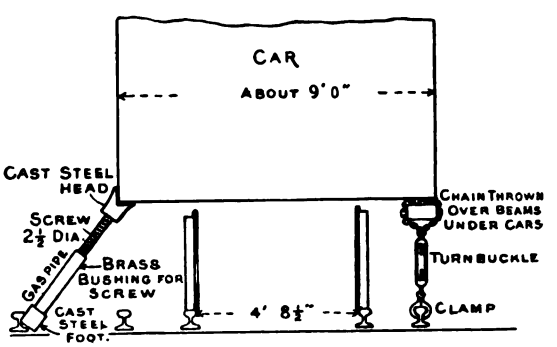
every 8 ft. apart are fitted in conjunction with stringer plate, all efficiently connected and bracketed. Midway between these beams and the main deck is another stringer, similar in all respects to the bilge keelson. The main deck beams are spaced every 24 in. apart, and are of 9 in. channel section connected to the frames with very large brackets. On top of these beams there is worked the main deck stringer and deck plating, the stringer plate being 66 in. wide and 30 lbs. per sq. ft. in weight; the rest of the plating is 17½ lbs. The main deck beams are supported by 3 rows of stanchions, of I section, spaced every 4 ft. to which are riveted continuous 12 in. channels these being also riveted to the lower flange of the beams. The upper deck beams are of bulb angles 6 in. deep, and spaced every 4 ft., supported by I stanchions, and continuous fore and aft channels. The center row of stanchions are spaced every 8 ft. and the outside rows every 12 ft. This deck is also entirely plated with steel 10 lbs. per sq. ft. in weight, except the stringer plate which is 17½ lbs.

The cabins are located on the upper deck. They are contained in two separate houses, one forward of the smokestacks and one aft, as shown in the plans. On top of the forward cabin is the pilot house, in which is placed both steam and hand steering gear. The steering engine is by Williamson Bros., of Philadelphia. The forward cabin contains the captain and mates rooms, the passenger saloon, 36 ft. by 10 ft., with 10 state rooms; the smoking room, 10 ft, 6 in. by 8 ft., with lavatory opening from the saloon; also accommodations for the chief engineer and purser, and toilet rooms for the passengers. The outside dimensions for this cabin are: 73 ft. 6 in. long and 24 ft. wide. The after-cabin, which is 49 ft. long by 24 ft. wide, contains the dining saloon, 16 ft. 6 in. by 11 ft.; the officers mess, and crews mess, with pantry and kitchen in connection. The assistant engineers, stewards, watchmen, and wheelsmen are quartered in this house. The main saloon and dining room are of pine, paneled and finished in white and gold, with hand-carved festoons worked on the panels. All the other rooms are of pine, ceiled and paneled, and finished plain white. At the extreme forward end of the vessel, on the main or car deck, are the sailors' quarters, all neatly finished. Above this crew space is a partial deck on which is located a steam windlass, mooring bitts, chocks, fairleaders, etc. The windlass is of the American Ship Windlass Company's build. On the main deck there are four steam gypseys; two on each side, also by the same company. The firemen's quarters are forward of the boilers, below the main deck, and very comfortable and well ventilated.

The propelling power of the Pere Marquette consists of two sets of fore and aft compound engines of the inverted direct connected type. The cylinders are 27 and 56 in. dia. by 36 in. stroke, and are entirely below the main deck. Piston valves are used on the high pressure cylinders, and double ported slide valves on the low pressure cylinders; all worked by double bar Stephenson link motion. The crankshaft is 13 in. dia. built up with crank arms 8 in. and 9 in. thick. The lineshaft is in five pieces 12½ in. dia. with forged coupling flanges. The propeller shaft is 13 in. dia. The propellers are 12 ft. in dia. by 14 ft. pitch, made of cast steel, and very heavy, for use in the ice. The airpumps are worked from the low pressure crossheads and are of 27 in. dia. by 18 in. stroke. Steam is supplied by four single-ended return tube boilers 15 ft. 3 in. dia. by 12 ft. long working under a steam pressure of 135 lbs. per sq. in. There are four furnaces to each boiler with grates 5 ft. 6 in. long. The total grate surface of the four boilers is 280 sq. feet, and heating surface 11,568 sq. ft. The tubes are 3¼ in. dia. and 8 ft. 11⅝ in. long, and there are 330 to each boiler. The boilers were built by Wickes Brothers, of Saginaw, Mich.

The auxiliary apparatus includes a feed heater, 25 in. dia. and 8 ft. long, with 80 1¾ in. tubes. Two duplex feed pumps, 10 in. by 6 in. by 10 in., made by Deane Bros., of Indianapolis. Bilge pumps 7 in. by 10¼ in. by 10 in., and fire and sanitary pumps by the same makers. There is an extensive electric lighting installation aboard. This consists of three complete sets of engines and dynamos of the vertical direct connected type. The two larger are of 15 K. W. and the smaller 4 K. W. capacity, supplying 10 arc lamps, 332 16 c. p. incandescent lamps and one search-light of 2,000 c. p. The machines are connected to the switch board, so that the three may be operated together but, ordinarily two machines only are used, one of the larger being kept in reserve. The lights are distributed between the car spaces on the main deck, the forward and after cabins, and the hold.

The Pere Marquette carries four life boats, and two life rafts, the life boats being carried abreast of the deck house, and resting on skids built of steel angles. The davits are hinged at the bottom and arranged to fall outboard, instead of swinging in the usual style. The two pole spars and two smoke stacks give the vessel a very fine appearance, and all throughout she reflects great credit



METHOD OF SECURING CARS ON FERRY.

on her designer and on her builders.

Since the Pere Marquette was put in commission she has given entire satisfaction to the owners

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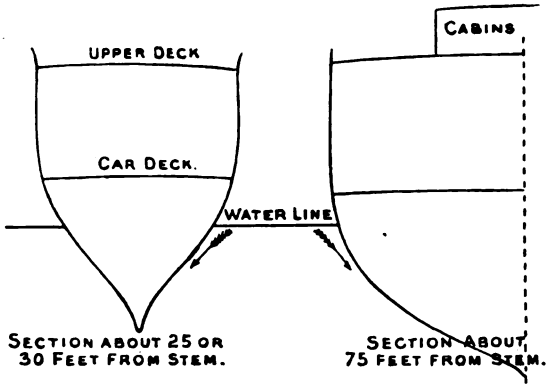
and exceeded the most sanguine expectations, Carrying a full load, in open water, she has easily attained a speed of 16 miles, exceeding the guarantee by 3½ miles. Though the past winter on the



DIRECTION TAKEN BY SHATTERED ICE.

lakes has been unusually mild, the ferry has had several rather severe tests. In February last she made her first trip, with 30 loaded freight cars aboard, in the teeth of a severe gale, other boats of the company having to turn back. She behaved admirably and the cars remained steadily in place as though they formed part of her construction. The method of holding the cars is shown very clearly in the accompanying rough sketch. Since that trip she has on occasions crushed her way, uninterruptedly, through solid ice 14 in. thick, at a speed of 10 miles an hour. The ferry has been designed very carefully with a view to successfully ramming the ice. The lines are very fine forward, and the boat under steam cuts her way very cleanly through the ice field, much of the shattered ice passing down under the boat. This can be better understood by examination of the rough sections here shown. During a hard winter, the ice on the route is frequently 2 to 3 ft. thick, and after severe gales the ice is piled up, or windrowed, to the extent of 8 or 10 ft. This of course is not solid ice. When the ferry is making her dock she has to go in stern first, and in winter there is usually great quantities of slush ice in the slip. On such occasions the propellors are used to wash it away.

The Flint and Pere Marquette R. R., which owns this fine vessel, runs through Michigan, from Toledo, Detroit, Flint, Saginaw, Bay City, and up through the northern portion of the lower peninsular to Ludington. From here it operates a line of passenger, mail, and freight steamers across Lake Michigan to Milwaukee, Chicago and Manitowoc. The Pere Marquette runs in the route between Ludington and Manitowoc, a distance of about 60 miles. The object of the company in building this vessel was to transport passengers and freight across the lake, without in the latter case breaking bulk. The Pere Marquette, which was designed by naval architect, Robert Logan, of Cleveland, has been such a success that the company will build a fleet of this exact type.

HIGH STEAM PRESSURES ON SEA-GOING SHIPS AND IN GENERAL.—2.

BY DR. R. H. THURSTON.

In large degree the gain of the century now marking the growth of the modern steam-engine out of the germ developed into modern form by Watt, when improving the invention of Newcomen, has come, especially in the earlier days of that progress, through devices which effected the reduction of this waste. Watt made the first step when he attempted to put in practice his well-stated principle—"keep the engine as hot as the steam which enters it"—and applied the steam-jacket with that end in view. The results of increased speeds of piston have been marked, in this direction, and these gains, reinforced by those due to increased steam-pressures and the otherwise unattainable elevation of the economical ratio of expansion, have led to such gains as are exhibited in the accompanying diagram, reduced from the records of the steam pumping engine.[1]

In the old Savery engine of two centuries ago, and until the engine of Newcomen became successful in displacing it, the wastes in this direction were nearly all, the utilized part but a minute fraction, of the steam supplied. At the commencement of the present century the work of Newcomen, of Smeaton, and of Watt had effected a grand beginning in the extinguishment of the internal wastes and, since the middle of the century, the progress made has been quite rapid and extensive. At the commencement of this period, as shown on the curve in diagram No. 3, the wastes, at about 1750, were 95 per cent of all steam, heat and fuel; by the beginning of the nineteenth century, Watt had brought them down to 30 per cent, and they have since steadily fallen until, to-day, in the best engines constructed, they are as low as 20 per cent, and, with superheating,

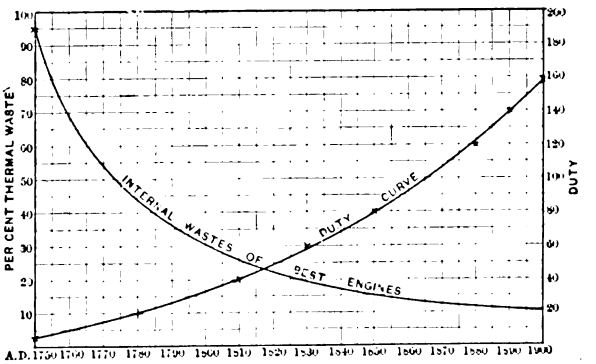


FIG. 3.—PROGRESS IN STEAM ENGINE EFFICIENCY.
Marine Engineering

considerably less. Meantime, the duty of the engine, as measured by the number of foot-pounds of work performed by 100 pounds of fuel, of best

[1] *Trans.* A. S. M. E.; Vol. xviii; No. DCCXVII.: p. b.

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quality, has risen from the five or six millions of the last century, to twenty in Watt's engines, to eighty millions at the middle of the century, and to about one hundred and fifty millions at the present time. And still the good work progresses and we should see one hundred and sixty millions reached by A. D. 1900.

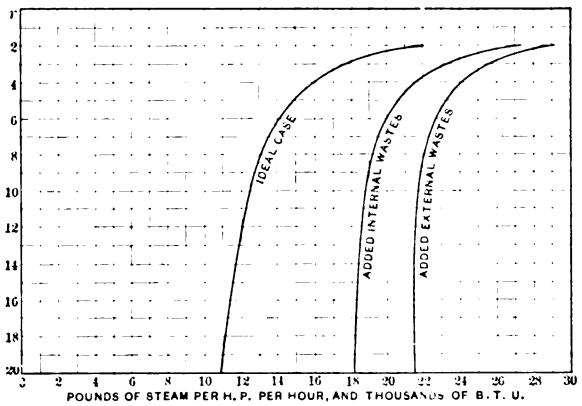

FIG 4.—MARINE ENGINE ECONOMICS.
Marine Engineering

The best work yet performed on land is about ten pounds of steam per horse-power and per hour, corresponding to about one pound of best fuel, as a minimum. The figure varies greatly, however, with pressure-variations, and the best work at one hundred to one hundred and twenty-five pounds pressure is between twelve and eleven pounds. The lower figure, above, has been approximated by best engines at 175 pounds or more, or with considerable superheating and in large engines. The diagram, No. 4 shows the more common figures for a triple-expansion marine engine in which something is necessarily sacrificed to insure that compactness, lightness and general effectiveness that is inconsistent with a design looking to maximum possible efficiency. The lower curve shows how the ideal engine, the purely thermodynamic machine, would vary in its consumption of steam, allowing about 2.3 pounds for perfect efficiency, unity, when steam is carried at 165 pounds and back-pressure stands at 4 pounds. The minimum here computed, at a ratio of expansion of twenty, is eleven pounds; but the line is still drooping, and, with reduced back-pressures and high expansions, a considerably higher figure might be found. When, however, the internal wastes are added, as shown on the next curve above, the minimum consumption of steam becomes 18 pounds, and the trend of the line shows that it is not far from its minimum in this particular case. When the friction wastes are now added, as shown on the upper curve, the minimum becomes above 21 pounds, and, even with the best possible boiler performance, the consumption of fuel could be brought no lower than about two pounds per horse-power per hour. The usual consumption of an engine of this type under the assumed conditions, is about two and a half pounds of fuel. With more liberal allowance of boiler-power, with dryer steam, with higher speed of piston, and especially with condensers producing a good vacuum, these figures may be brought down to 16 pounds of steam, and under two pounds of fuel, without difficulty, and such figures have been often now attained. The diagram, however, may be taken as a fairly representative one.

The future of the marine engine, if we may judge by the trend of our curves, is by no means likely to exhibit an early suspension of the progress already observed. The curves are all still extending in the direction of improved efficiency and increased utilization of heat, stored in steam, by thermodynamic conversion in the standard forms of marine engine. The now evidently fast-coming revolution in boiler-construction, the introduction of the water-tube boiler, is important as removing some serious obstacles to further increase of steam-pressures, and the only question in the mind of the designing engineer is now how far will it pay to go in the attempt to secure additional progress in this department of economics. But gain is certain to be less and less, proportionally, as pressures rise and as expansion is correspondingly increased, and we cannot, at best, secure more than a gain of 50 per cent. in steam and fuel, in increasing pressures, from the one hundred pounds usual, only lately, to ten times that figure. The gain is probably logarithmic, thus[5]:

Pressures.....	100	200	300	500	1000
Expansions.....	15	30	45	75	150
Steam used per I. H.P.	13-15	11-13	10-11	9-10	8-9

and the best of designers and constructors cannot hope to do better than is indicated above, under ordinarily favorable conditions, if we may judge the future by the past. The limit, wherever it may be found, will undoubtedly be a commercial one, and will be reached at some point far inside of that set by purely thermodynamic considerations. That we shall pass the limit at 250 pounds per square inch is, probably, not at all to be expected; that it will be found as high as 1,000 pounds seems to the writer, at present, at least, exceedingly doubtful; that 500 pounds may prove commercially available would seem not impossible. Experience, to date, indicates, in the opinion of the writer, that when they are employed, the engineer will be able to utilize as nearly the full thermodynamic value of the coming high pressures as he has, in the past, realized that of the lower pressures now being constantly more and more exceeded.[6]

That continuous rise in steam-pressures may be expected for some time—for a long time, probably—and ultimately to the limit set to its control by the strength of our materials, none can doubt. But at what point that limit will be set

[5] [6] Ibidem.

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by inability of our, as steadily improving, materials of construction to resist the combined effects of high pressure and high temperature, no one can say. Nor can we say how far we shall be able, at as yet unattained pressures in the marine or other steam engines to approximate the ideal case by reduction of the wastes of the real engine. Assuming, however, that we may anticipate at least as much success in this direction, at high pressures, in the future, as at the present comparatively low figures, the accompanying sketch will indicate what may be hoped for, and it may aid in determining whether it will finally pay to struggle for the higher thermodynamic results. In the figure, let the curve at the left represent the performance of the ideal, perfect engine—diagram No. 5—perfect in the sense of exhibiting no extra-thermodynamic losses. Let the curve at the right similarly exhibit the costs of power in a real engine of such proportions that the heat, steam, and fuel supplied will be subject to a loss of one-half by extra-thermodynamic action. Experience, so far as it at present guides us, appears to indicate that we may expect to find it practicable to keep down this waste at high pressures to the extent that it is now held down, under usual conditions, in the simple engine. Should it prove practicable, also, throughout so wide a range of pressures, to reduce it by compounding or otherwise, to one-half the amount assumed as a minimum for the simple engine at such pressures, the curve *C* results; and if, by adding a third cylinder, in series, reduction to one-third may be hoped for, the curve *D* exhibits the presumable costs of power, in pounds of steam per horse-power per hour, or, if the feed-water is suitably heated by waste heat in the flues or from the exhaust, in, it may be assumed, thousands of *B. T. U.*, or, again, in tenths of a pound of good fuel consumed in good boilers. In the same way, the quadruple-expansion engine, with its added cylinder intercepting the otherwise wasted leakage and cylinder-condensation of its predecessors, in series, may perhaps bring down costs to the figures indicated in curve *E*. A non-conducting cylinder would make them as shown on curve *A*. Any and all of these curves, *A* excepted, would seem to represent practicabilities to the engineer, and curve *E*, at least, the ultimate probabilities. In any event, the latter will make a good point at which to aim with hope and courage.

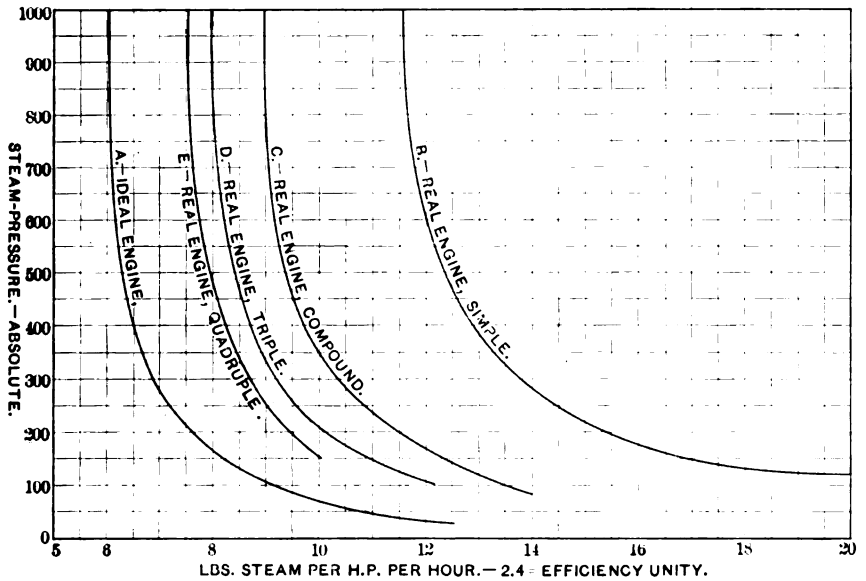

FIG. 5.—ECONOMY OF HIGH STEAM PRESSURE.

It will be interesting to note that, as better performance is insured by improved construction of engine, the advantages of higher thermodynamic efficiency are approximated more and more closely at progressively lower pressures and that, at the limit *E*, five hundred pounds pressure gives very nearly as good results as one thousand, and it may prove that, all things considered, it will not be advisable to carry the steam pressure to as high a figure as would, at first thought, appear desirable. It does not follow, however, that superheating, or other expedients for the attainment of a wider thermodynamic range of heat-conversion at manageable pressures may not continue commercially advantageous.

We have already, both in the gas-engine and in the steam-engine, brought down the cost of power, in coal consumed, to about one pound per *I. H. P.* per hour; it may prove that another third or even half of the remaining wastes of the steam-engine, and even a higher proportion in the gas-engine, may be extinguished. The question, lying beyond this, of the relative standing of these forms of heat-engine, and of the possible substitution of a machine in which the fuel is burned in the engine-cylinder, in which the products of combustion are the working fluids, and in which maximum visible range of thermodynamic action seems possibly attainable, for the familiar steam-engine, with its at present superior advantages in mechanical efficiency, in high mean effective pressure, its low cost of maintenance, its long life, its handiness in manipulation, in stopping and starting, and its perfect regulation by economical methods, is one which interests every engineer, but one which none can at present answer positively.

A new steamship line between Galveston and New York is a probability of the near future.

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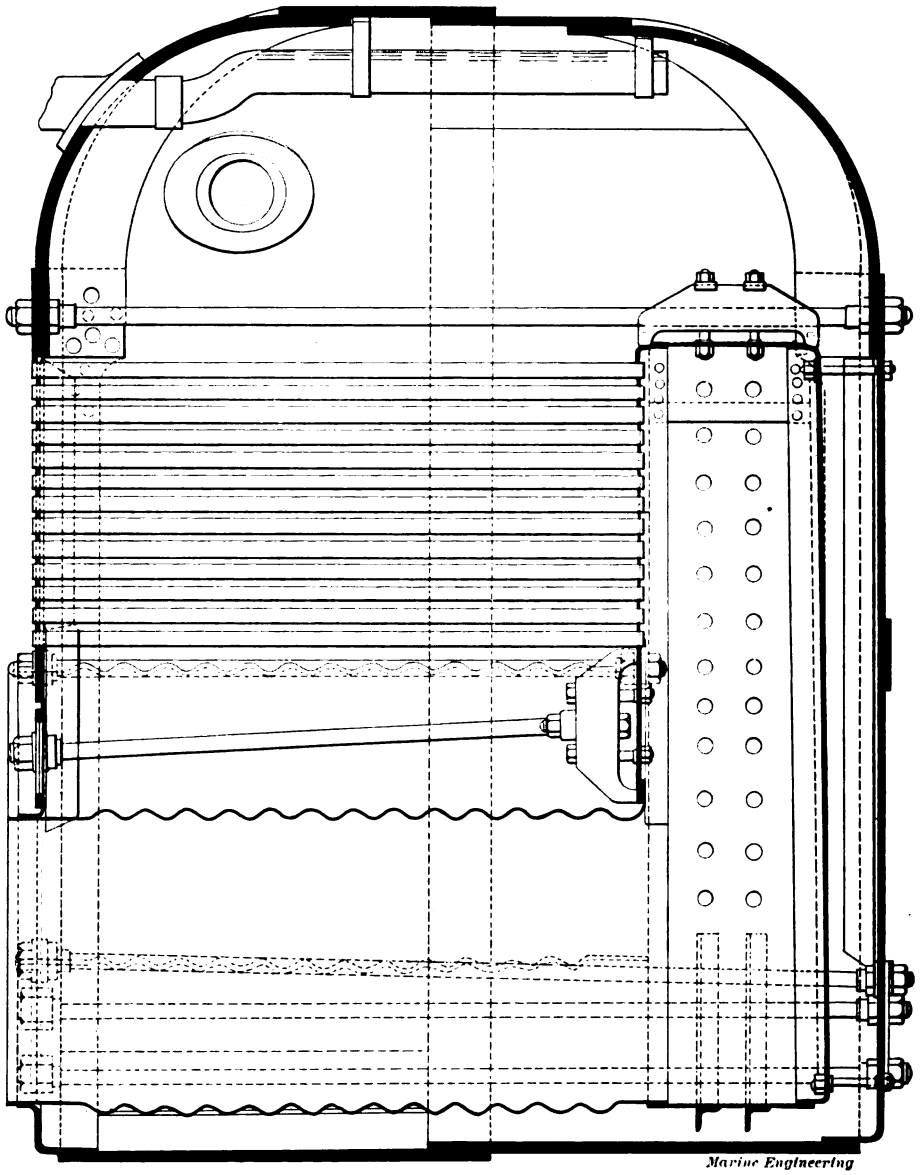
NEW SCOTCH BOILERS FOR U. S. S. CHICAGO.

The accompanying illustrations show one of the four Scotch boilers constructed in the Navy Yard, at Brooklyn, N. Y., for U. S. Cruiser Chicago. In the April issue a description of the engines was given. The photograph of the finished boiler which is here reproduced is of special interest, as this is the first nickel steel boiler built in the United States, if not in the world.



SECTION OF SCOTCH BOILERS FOR U. S. CRUISER CHICAGO.

When the decision was reached to refit the Chicago with new machinery, including a combination of Scotch and water tube boilers, Engineer-in-chief, George W. Melville, U. S.N., decided to give nickel steel a fair trial. It was a progressive step, and one likely, possibly, in time to exert a great influence over the selection of material for boiler construction. Plans for the boilers of the Scotch type were drawn by the Bureau of Steam Engineering, and bids were asked for both nickel and carbon steel. The figures at which the material was offered were such that it was decided to build all four boilers of nickel steel. Preparations were accordingly made at the Navy Yard, by Chief Engineer, Edward Farmer, U. S. N., for the proper treatment of the material. The specifications called for steel, 3 per cent nickel, of a tensile strength of 80,000 pounds, with an elongation of at least 25 per cent in 8 in., and an elastic limit of at least 50,000 pounds per sq. in. When the material was delivered at the yard it was soon foreseen that it woud give trouble. The test pieces showed that the quality was up to contract requirements, but the actual condition of the

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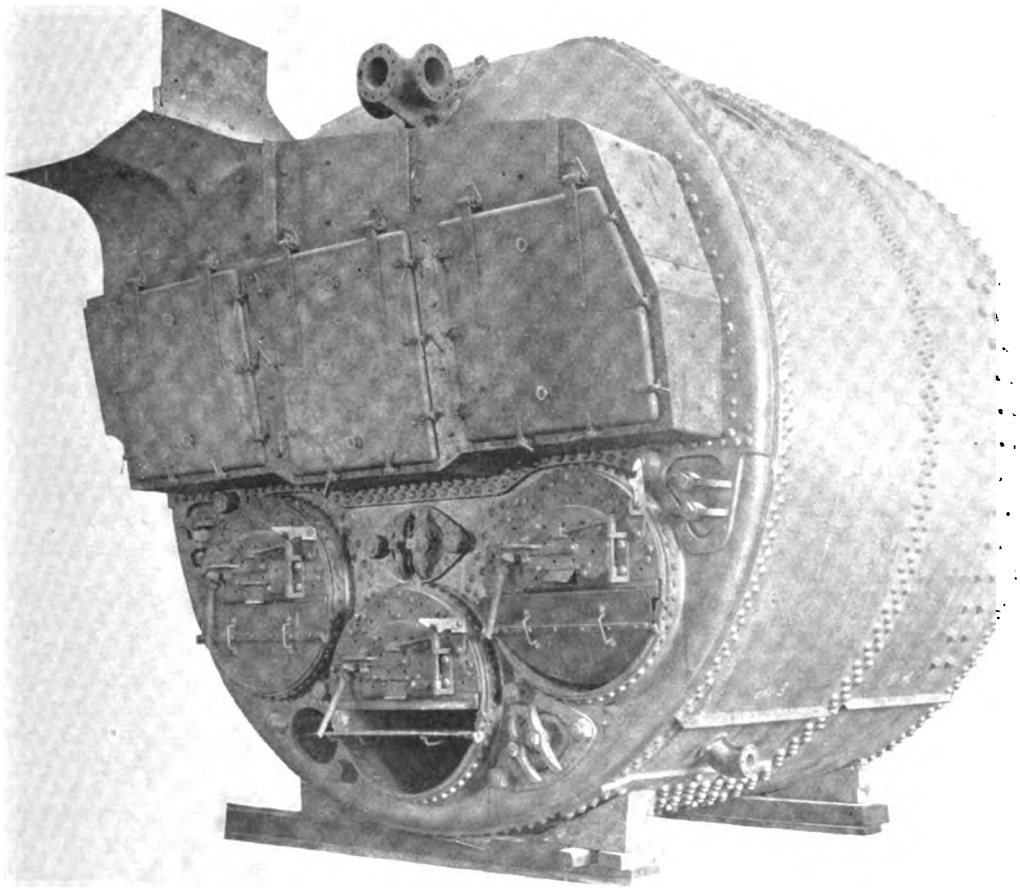
plates caused the greater part to be condemned. They were badly pitted and scored, as though slag or other waste had been drawn through the rolls. Indeed so pronounced was the badness of the plates that the modified plan to build even one nickel steel boiler came near being abandoned. By careful selection, however, sufficient good plates were laid out for the construction of the shell and heads of the boiler here shown. The combustion chambers, flues, tube sheets, stays, and rivets are of open hearth steel, and the tubes, charcoal iron. All four boilers are identical in dimensions with this one. They are of the single-ended type, 13 ft. 8½ in. dia., and 10 ft. 1½ in. long. A peculiarity of design as will be noticed in the sectional drawing, is the rounded upper ends, which saves a number of stays, only one row being necessary in each boiler above the combustion chamber. These sections are curved to a radius of 3 ft. Another feature, which is in line with modern naval practice, is the isolation of each furnace, with its combustion chamber and return tubes. This prevents accidents when the vessel is steaming under forced draft, should more than one door in the boiler be opened at the same time. The thicknesses of plates used are: shell, 1 5-16 in.; back plate, 3-4 in.; furnace sheet, 3-4 in.; front tube sheet, 7-8 in.; back tube sheet, 3-4 in.; back and sides combustion chamber, 9-16 in., and crown sheet, 9-16 in. The furnaces are Fox's patent, 3 ft. 5 in. inside dia., and 19-32 in. thick, with corrugations 2 in. deep and 6 in. pitch, the corrugations of the center furnace alternating with the corrugations of the wing furnaces. The grates are 6 ft. 7 in. long, the bars being double, of wrought iron, riveted together with distance pieces. The bottoms of the combustion chambers are strengthened by 3 by 3 by 1-2 in. angles. The tops of the chambers are each spaced with five girder braces, made up of two shapes, 7-8 in. thick, held down by 1¼ in. bolts and [washers. For stiffening the back plate two T bars are riveted to the plate between the combustion chambers, following the curve of the



NICKEL STEEL BOILER FOR U. S. CRUISER CHICAGO.

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sides of the chambers. These are 4 by 5 in. by 1-2 in. thick. There are nine stays in the upper row. These are of a tensile strength of 60,000 to 70,000 pounds and a ductility of 26 per cent. in 8 in. The stays are 2⅝ in. thick, swelled at the screwed ends to 2⅛ in. The back tube sheet of the center furnace is very substantially braced with 1½ in. shapes, stayed to the front furnace plate and manhole ring by two 2 7-16 in. rods. The wing furnaces are also stayed direct to the front, without the interposition of any braces. There are six bottom stays 2 3-16 in. dia., swelled at the screwed ends to 2½ in. The boiler contains 417 tubes, of which 143 are in the center nest and 137 in each of the wings. Of these tubes 113 are stay tubes 7 ft. 5½ in. long, 2¼ in. O. D., and 6 B. W. G. in thickness. The ends are screwed 12 threads to the inch. Those which pass through the back tube sheet are reinforced to an outside dia. of 2⅜ in. for a length of 2¼ in., the bore being uniform, and the ends passing through the front tube sheet are reinforced to an outside dia. of 2⅜ in., for a distance of 3 in., and swelled to 2½ in. O. D. The ordinary tubes, of which there are 304, are the same length and dia. of 10 B. W. G. The ends passing through the back tube plate are of even gauge and parallel, with beaded ends. The front ends are swelled to an outside dia. of 2 5-16 in., for a distance of 3 in. All the tubes project 1-4 in. beyond the front tube sheet. They are spaced 3½ in. centers. The edges of the nests are 11 in. apart, and the combustion chambers are 5½ in. apart. They are stayed to each other and to the shells by 1¼ in. stay bolts, swelled to 1⅜ in. at the screwed ends. The tubes were tested to 500 pounds pressure.

The rivets used have a tensile strength of 55,000 to 65,000 pounds and a ductility of 26 per cent in 8 in. They were subjected also to very severe shop tests. The sizes of the rivets vary from 15-16 in. to 1 5-16 in., these last being used for the shell seams. The shell plates have butt joints with double straps, 1 in. thick, treble riveted, with every alternate rivet omitted in the outer row. The rivets in the straps are 15-16 in. dia. Wherever possible, on the shell and chambers, riveting machines were used. For the principal joints in the boiler the mean of the percentage of rivets and plates is: of rivets, 66.477; of plates, 67.953.

Coming to the steam generating capacity of the boiler, the totals of heating surface in square feet are: tubes, 1770.61; furnaces, 134.64; combustion chambers, 166.72; tube sheets, 66.18, a total of 2138.15 sq. ft. The grate surface is 68.33, and the calorimeter 8.8 sq ft.. The evaporative power is 21, 866 pounds per hour, which is equal to 10,488 gallons per hour for the four boilers; or, say, 175 gallons per minute. The weight of the boiler is, approximately, 43 tons. It is to be worked at a pressure of 180 pounds. The hydrostatic test, to 280 pounds, was applied with the most satisfactory results.

In building the nickel steel boiler great difficulty was experienced in working the plates. They resisted all tool work and bending to such an extent that the extra cost for labor of this boiler, as compared with the carbon steel boilers, was fully 20 per cent. The edges of cutting tools were turned or fractured, and while bending the plates the housings of the biggest rolls in the boiler shop were smashed. The corrosion resisting qualities of the material were shown in the pickling. It took just five times as long to dissolve the scale on the nickel plates as it did on the carbon plates. If this is any indication of the possible life of the boiler the increased cost may be more than offset by the durability. The future behavior of this particular boiler will be watched with interest, though, of course, a very long period must necessarily elapse before any real estimate can be made of its special value.

THE OPERATION OF WATER-TUBE BOILERS IN WARSHIPS.*

BY REAR ADMIRAL C. C. P. FITZGERALD, R.N.

Before entering into the merits of the water-tube boiler it may be as well to take a glance at the merits of the boiler which it seems likely to supersede; and under this head, I believe, I shall find many to agree with me when I say broadly, that there never was a period, during the development of boilers for warships, when their general behavior has been so unsatisfactory, and when they have given so much trouble, and been the cause of so much anxiety, as during the last ten or twelve years. I speak as an interested looker-on, who often sees a good deal of the game; and my conclusion is that the Scotch and marine locomotive type of boilers have proved themselves to be unequal to the demands made upon them for the greater pressures and quantities of steam required for the working of fast-running triple-expansion engines. It has been one long monotonous tale of leaky tube-plates and seams, bulged fire-boxes and generally more or less disabled and inefficient boilers. The instrument has proved to be unsuitable to the work required of it, and it has failed.

I shall not attempt to argue whether the boilers of the Belleville type, which are now being fitted in so many of her Majesty's ships, are, or are not, the best type of boilers of this family; but it may be stated broadly that most of the special attributes of the Belleville type are claimed for all other water-tube boilers in a greater or less degree; and no doubt the inventors and patentees of the latter will be able to show claim to many other virtues in addition. The power of being able to raise steam rapidly in a warship is of great importance; under certain circumstances it might

* From a paper read before the Institution of Naval Architects, in London, April 7, 1897.

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be vital. The Sharpshooter[1] (with Belleville boilers) has raised steam in 20 minutes from "fires out" and cold water. She would have taken two or three hours with her old boilers, and, had she tried to do it in less, she would almost certainly have caused leaks; but this rapid raising of steam causes no injury to water-tube boilers, nor does rapid cooling. The ability to make large and rapid increases of speed is of high tactical value to a squadron of battleships; but it is of still greater importance in the case of a cruiser, whether she is employed in scouting, or as a look-out ship, or as a commerce protector, cruising on a trade route. With the Scotch boiler a ship has to be worked gradually up to her full speed, but with a water-tube boiler even a large ship can start off almost like a torpedo-boat.

The Terrible on January 9 was lying in Plymouth Sound with her head to the eastward; at 8:25 she got under way, and had to turn around to get out by the western channel, and at eight minutes past 9, that is to say in 43 minutes, she was going 20 knots. This performance could not have been approached had she been fitted with cylindrical boilers. There can be no question that anything which tends to reduce the disastrous consequences of a violent injury to a boiler, such as might be expected in time of war, is a point well worthy of consideration. And when it is mentioned that each of the Powerful's boilers holds only one ton of boiling water, and that each of the Majestic's holds nearly 22 tons, it will not be necessary to enter into an elaborate argument to prove the comparative safety of the two systems. Boilers of the water-tube type can be cooled with great rapidity, and without any injury, so that they can be quickly examined, cleaned, and, if necessary, repaired. This rapid cooling cannot be done with Scotch boilers without the risk of causing leaky seams and tube plates. That there is a great saving of weight in an installation of Belleville boilers as compared with Scotch boilers, for similar horse-powers, is an indisputable fact. It has been estimated variously in the case of the Powerful and Terrible at from about 400 to 700 tons. If we take for comparison a ship of about the same tonnage, though of less than half, the horse-power—the Majestic, for instance—we find that the weight of her boiler installation, including funnels, uptakes, etc., is 745 tons for 10,000 horse-power, with natural draught, and 12,000 horse-power, with forced draught. The Powerful's boiler weight (similar adjuncts included) is 1,164 tons. She is not fitted with forced draught, and gets her 25,000 horse-power easily without the assistance of that rather doubtful blessing. Her boiler weight with Scotch boilers to get 25,000 horse-power with natural draught, at the same ratio of weight per horse-power as Majestic, would have been 1,862 tons, and with forced draught 1,552 tons. Thus in one case there is a saving of nearly 700 tons, and in the other of 388. The former is undoubtedly the fairest comparison, as forced draught is not generally used in warships except on the trial trip. As to space, there seems to be very little difference in the floor space required for a set of Belleville and a set of Scotch boilers for similar powers. If anything, it appears that a set of Bellevilles require rather more floor space. The evaporative efficiency of Belleville boilers seems to be at least equal to that of the best Scotch boilers as fitted in warships, and I am making no comparison with merchant ships, where the conditions are different. Taking the 30 hours' coal consumption trial of the Powerful, at 18,500 horse-power she burnt 1.81 lb. per indicated horse-power; and the Terrible at the same horse-power burnt 1.71 lb. per indicated horse-power. This was with the engines developing 75 per cent of their maximum power. Comparing this with the 30 hours' coal consumption trials of other large ships with modern engines and cylindrical boilers we find Renown 1.88 lb. at 6,204 I. H. P.; Majestic 1.83 lb. at 6,094 I. H. P.; Magnificent, 1.68 lb. at 6,116 I. H. P.; Sultan, 1.77 lb. at 4,018 I. H. P.; Prince George, 1.82 lb. at 6,216 I. H. P.; and Victorious, 1.6 lb. at 6,205 I. H. P. In these cases the engines were working at 50 per cent of their designed powers, which is about their most economical rate of working per indicated horse-power. The Sharpshooter on her long sea trials varied between 1.7 lb. and 1.9 lb. of coal per indicated horse-power. While desirous of being absolutely impartial on the boiler question, I find that my remarks have been almost entirely favorable to water-tube boilers, and especially so to the Belleville type, that being the type which interests us most, as it is being fitted in so many of our large cruisers, and in the new battleships; but I need scarcely say that I have no interest in the matter, beyond the interest of wishing to see the best type of boiler in all our ships, both large and small. I have been trying to find out something against the Belleville boilers, but I have not had much success. The advantages of water-tube boilers, which I have endeavored to point out, though they will be duly appreciated by executive and engineer officers during ordinary peace service, seem to be just exactly of that particular nature which will cause them to be specially conspicuous under the rougher, more sudden, and more urgent demands of war.

[1] The Sharpshooter was originally fitted with wet bottom locomotive boilers.

The new locomotive jib crane in the Navy Yard at Mare Island, Cal., is said to be the biggest of its kind in use anywhere. Its capacity is 45 tons, raised at the rate of 14 ft. per minute. The boom will reach 75 ft. from the center of the track, and when it is elevated, 60 ft. The boom can be shifted between these distances in 11 minutes, and the time occupied in making a complete revolution is two minutes. The jib crane runs on tracks 20 ft. apart.

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A CLASSIFICATION OF THE WAR VESSELS OF THE WORLD.

BY BERNARD A. SINN.

In numerous naval pocket books and annuals published in recent years, tables purporting to show the strength of the various navies of the world have been included. In most instances, however, there has evidently been no attempt made to systematically classify the various types of vessels, nor take proper account of the characteristics of each. For example, the Austrian naval pocket book, which is admittedly the most complete in the matter of tabulation, classifies vessels as battleships, coast defense vessels, armored cruisers, protected cruisers, and unprotected cruisers; and each of these classes is again divided into two large divisions, depending on date of build. These are also subdivided on the basis of displacement. In these tables the classification adopted is that of the country to which the vessel belongs. Thus the Italians call the Re Umberto a battleship, but as the vessel carries only four inches of armor on her sides, the nomenclature is incorrect. In this pocket book, the Re Umberto is classed as a battleship simply because Italy considers it so, and not because of any characteristics of the vessel. Mr. Laird-Clowes in his excellent naval pocket books, makes a somewhat more accurate classification, but along the same lines as the Austrian publication. In all cases, of course, the classification was intended to include all types of vessels, and the only difficulty is, that Mr. Clowes gives no rules for distinguishing the cruiser from the battleship.

The classification here adopted takes account of the following characteristics. First, size as represented by displacement; second, speed as represented by trial speeds, or in case the vessel has not been tried, the highest speed expected; third, armor as given in the various naval annuals, and in the reports to the legislative bodies of the various countries; fourth, modernness as represented by the date of launch. This latter is a very important consideration, for it is almost invariably a gauge of the kind of armor with which a vessel is protected. Vessels built prior to 1885 were fitted with what would now be considered an inferior kind of armor. The same general rule applies to ordnance, as rapid fire guns were adopted almost simultaneously with nickel steel, and surface hardened armor. It will be readily understood, however, that the accompanying tables are intended for the distinguishment of war vessels generally, and not to include what might be called extraordinary refinements which are usually not obtainable. The purpose is rather to bring together, comparatively, vessels having the same general characteristics and of about the same dimensions.

The ideal classification, of course, would be to consider size, speed, coal endurance, armor, and armament, and reclassify each of these general divisions into subdivisions depending upon the design, modern or obselete conditions, etc.; but that is outside of the scope of this article. The nomenclature here presented is not that adopted by the different countries included, as such a combination would be chaotic. It might be well to note the different values assigned various types of vessels by the powers. England calls the improved Renown class, first-class battleships; yet these vessels carry but six inches of side armor, and it is obvious that such a vessel is not a battleship. Likewise the Italians put their Sardegna in the battleship class, but as this vessel carries only four inches side armor it would be more consistent to call it an armored cruiser. The Russians call the Rossia an armored cruiser, but this vessel has eleven inches side armor, and therefore, would be nearer to the battleship class; and so throughout the world's navies. One vessel is called a cruiser and really approaches the battleship type, and another is called a battleship and approaches the cruiser type.

The greatest difficulty in all matters of this kind is to draw the dividing line. This is purely arbitrary, for no two persons have exactly the same ideas upon the subject. The best opinion seems to be, however, to call any vessel a battleship, which has ten inches armor, and fourteen inches turret, barbette, or citadel armor. There is no scientific reason why eight inches or twelve inches might not be chosen, but ten inches seems to be about the rational limit, owing to the fact that a battleship must meet vessels carrying very large and very heavy ordnance. As the eight inch and ten inch guns would penetrate less than ten inches of armor, this thickness has been generally determined upon as the minimum thickness for battleships. Armored cruisers are all armored vessels of high speed, not having the perquisites, as regards armor, of a battleship, but still carrying heavy ordnance, and armor protection other than a protective deck. This would include then, vessels carrying more than four inches of armor and less than ten. Thus the classification is based primarily on protection from gun fire; secondly, speed; thirdly, size; and fourthly, date of build, which takes account of improvements in armor, armament, and construction. It will thus be seen that the object of this article is simply to offer a suggestion as to the classification of vessels of war, calling all vessels of 5,000 tons displacements, first rates; all over 3,000 tons, second rates; all over 1,000 tons, third rates; and all under 1,000 tons, fourth rates; or calling a battleship a first-class battleship because it is the best ship in the navy to which it belongs.

Table I shows the classification adopted, and Table II the number of vessels each navy possessed in each class on January 1, 1897. Where no date of build is given, in the column headed "date of build," it implies that the class is given irrespective of build. Where no thickness of armor is given, means that none is carried, and where no limit of speed is specified, means without

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reference to speed. Each vessel is placed in the highest class to which it is entitled.

The last four lines in Table II are given to a numerical comparison of the following navies :

First—England against France and Russia.

Second—England against the triple alliance—Germany, Italy and Russia.

Third—United States against Spain.

Fourth—Greece against Turkey.

The plus (+) sign means that the first named country has that many more ships than the navies with which it is compared, and the minus (—) sign, means that the first named country is weaker by that number of vessels.

With these tables, therefore, a comparison can be made between the several classes in each navy.

TABLE I.

CLASS.	NOMENCLATURE.	DISPLACEMENT, TONS.	ARMOR.	SPEED, KNOTS.	DATE OF BUILD.
1	1st Class Battleships.	10,000	10 inches side. 14 in. turret or barbette.	15	After 1885.
2	2nd Class Battleships.	9,000 6,000	10 in. side. 10 in. turret. 10 in. side. 14 in. turret.	13 15	..... After 1885.
3	3rd Class Battleships.	9,000 6,000 4,000	10 in. side. 10 in. turret 10 in. side. 10 in. turret. 10 in. side. 14 in. turret.	10 13 15	.... After 1885.
4	1st Class Armored Cruisers.	8,000	4 to 10 inches side armor.	17	After 1885.
5	2nd Class Armored Cruisers.	8,000 4,500	4 to 10 inches side armor.	15 Mls 17 Mls	..... After 1885.
6	1st Class Coast Defense Vessels.	3,500	Over 4 in. armor and not included above.	.....	.....
7	2nd Class Coast Defense Vessels.	Under 3,500	Over 4 in. armor and not included above.	.....	.....
8	1st Class Protected Cruisers.	7,000	Over 1 in. protective deck.	18	1885
9	2nd Class Protected Cruisers.	7,000 4,000	Over 1 in. protective deck.	16 18	1880 1885
10	3rd Class Protected Cruisers.	7,000 4,000 2,000	Over 1 in. Protective Deck.	13 16 18	1875 1880 1885
11	4th Class Protected Cruisers.	All protected vessels not included above.	Over 1 in. Protective Deck.	.....	.....
12	1st Class Cruisers.	4,000	None.	18	1885
13	2nd Class Cruisers.	4,000 2,000	None.	15 18	1880 1885
14	3rd Class Cruisers.	3,000 2,000 1,000	None.	10 15 18	.... 1880 1885
15	4th Class Cruisers.	1,000	None.	.....	.....
16	Torpedo Vessels.	600 to 1,000.	None.	18	.....
17	Torpedo Gunboats.	200 ft. and over.	None.	18	.....
18	Torpedo Boat Destroyers.	Under 1,000.	None.	26	.....
19	Sea-Going Torpedo Boats.	150 ft. and over.	None.	.....	.....
20	1st Class Torpedo Boats.	100 to 150 ft.	None.	.....	.....
21	2nd Class Torpedo Boats.	75 to 100 ft	None.	.....	.....
22	3rd Class Torpedo Boats.	Under 75 ft.	None.	.....	.....

TABLE II.

CLASS ..... COUNTRY.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
ARGENTINE	..	..	..	2	..	1	4	..	1	2	1	..	..	1	..	..	2	4	..	10	..	14
AUSTRIA	..	2	5	..	2	6	..	..	2	..	..	..	3	10	2	..	..	2	..	55	7	..
BRAZIL	..	..	2	..	..	2	4	..	..	..	1	2	4	4	4	..	..	6	7	..	..	12
CHILE	..	..	1	1	1	..	1	..	1	3	1	..	1	1	1	3	..	4	6	7	3	4
CHINA	..	..	..	..	..	..	..	..	..	3	1	..	..	5	1	1	..	4	..	9	11	2
DENMARK	..	..	1	..	..	1	7	..	..	..	..	..	..	4	3	..	..	..	..	12	12	..
ENGLAND	19	11	7	17	7	29	5	21	24	46	16	1	10	10	23	6	4	90	1	20	14	82
FRANCE	17	13	12	3	..	7	9	4	18	14	12	..	..	..	29	6	10	6	8	190	28	14
GERMANY	7	1	8	1	6	9	13	..	3	..	..	..	3	5	23	2	..	2	10	127	..	2
GREECE	..	..	3	..	..	..	1	..	..	..	..	..	..	..	3	..	..	..	..	12	7	12
ITALY	5	..	..	11	1	5	2	..	..	8	6	1	..	3	18	13	2	4	1	131	7	20
JAPAN	3	..	1	..	1	1	3	2	..	7	2	..	..	..	15	..	..	..	4	31	..	16
NETHERLANDS	..	..	..	..	..	5	20	..	3	1	1	..	..	6	4	..	..	..	..	15	22	..
NORWAY	..	..	..	..	..	2	4	..	3	..	..	..	..	..	4	..	..	..	1	10	6	..
PORTUGAL	..	..	..	..	..	..	6	..	..	..	..	..	..	1	11	..	..	..	9	9	3	..
RUSSIA	10	9	4	5	2	5	29	..	3	2	2	..	..	1	17	..	3	4	..	71	5	98
SPAIN	1	8	..	..	2	1	..	2	..	..	3	..	..	6	6	10	1	..	..	12	1	4
SWEDEN	..	..	..	..	..	..	19	..	..	..	..	..	..	..	3	3	..	..	..	21	1	..
TURKEY	..	1	1	1	..	4	8	..	2	..	..	..	..	2	4	2	3	..	3	20	1	1
UNITED STATES	9	2	..	2	..	6	14	2	6	3	2	..	3	1	27	1	..	6	8	4	1	4
ENGLAND AGAINST FRANCE AND RUSSIA	—8	—11	—9	+9	+5	+17	—33	+17	+3	+30	+4	+1	+10	+9	—23	..	—9	+80	—7	—241	—19	—30
ENGLAND AGAINST GERMANY, AUSTRIA AND ITALY	..	+7	+8	—6	+5	—2	+9	—10	+21	+19	+38	+10	..	+4	—8	—20	—9	—2	+82	—10	—193	..	+60
UNITED STATES AGAINST SPAIN	+8	—6	..	+2	—2	+5	+14	..	+6	+3	—1	..	+3	—5	+21	—9	—1	—6	—8	—8	..	—30
GREECE AGAINST TURKEY	..	—1	+2	—1	..	—4	—7	..	—2	..	..	..	..	—2	—1	-2	—3	..	—3	—8	—6	—11

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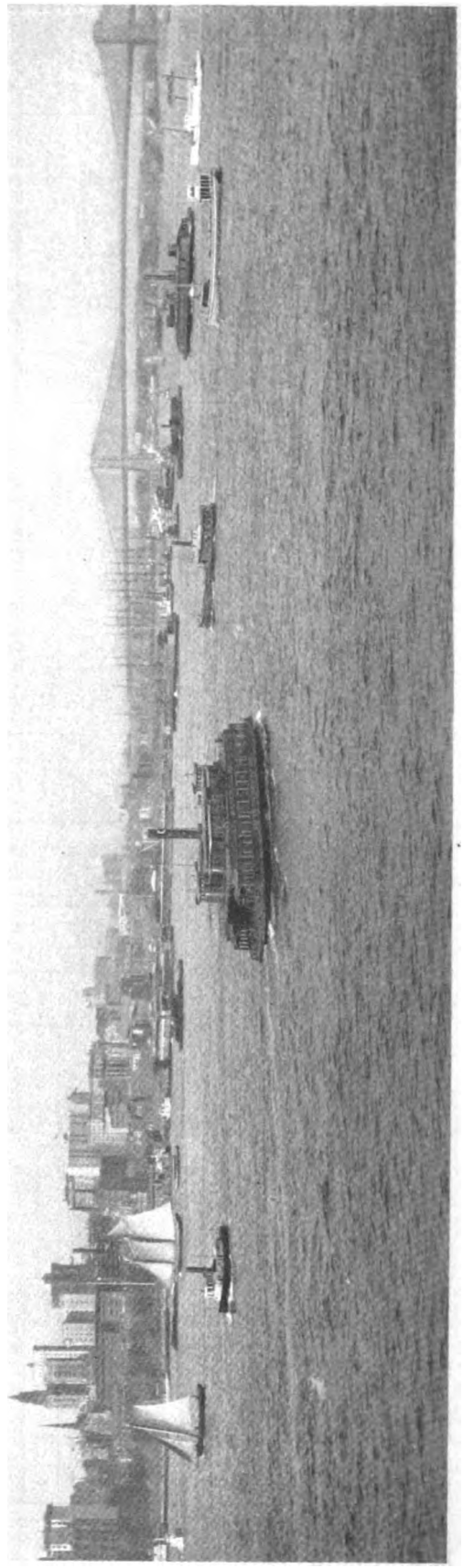
THE ORIGIN AND DEVELOPMENT OF THE FERRYBOAT.—2.

BY EDWIN A. STEVENS.

Having briefly reviewed the evolution of the ferryboat, let us take into consideration the condition under which its designer works, and the demands that he must meet. Like every vessel, the ferryboat must be suited to its work, and this work—as we have already seen—varies; but even under conditions of the same kind of travel on neighboring routes, some consideration of major importance may so wholly change the design as to render the vessels entirely dissimilar. As an example of this fact, the ferries from the foot of Cortlandt street, New York, to Jersey City, and the Staten Island ferry, may be cited. On both these routes there is a heavy travel of passengers and teams; the distribution throughout the day being a little more even on the Jersey City ferry than on the Staten Island. The climatic conditions are, of course, the same. The course of the Jersey City boat is directly across the lower Hudson, about three-fourths of a mile in length. The Staten Island boat crosses the mouth of the East River, and runs across the upper bay and the outlet of the Great Kills. The length of the route is about five and one-quarter miles. At Cortlandt street, the tide makes but little difference in the running time, as the current is at right angles to the course of the vessel, and in whichever direction it may be running will offer about the same difficulties and impediments. On the Staten Island routes, however, the greater part of the course has to be covered with either a favoring or a head tide, and portions of it are subject to varying cross currents. The round trip on the Cortlandt street route can be easily run in half an hour, of which from twelve to fourteen minutes will be spent under steam, and about one-third of this time at half speed or backing. On the Staten Island route, however, the round trip will occupy about one hour and twenty minutes, of which from fifty to fifty-five minutes will be under steam, and of this about five minutes will be at half speed or backing. It is very evident that the saving in time, due to increased speed, would yield but a small gain at Corlandt street, while it would be an important factor at Staten Island. A moment's consideration also will show that the boiler power of the boats at Staten Island will have to approach very closely to the full capacity of the engines; while for the short run at Cortlandt street, if sufficient water surface for the liberation of steam, and room for its storage be provided, the boiler capacity may be considerably



FERRY TRAFFIC AT THE MOUTH OF THE EAST RIVER, NEW YORK HARBOR.

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decreased below that necessary to continuously supply the engines at full power.

Requirements of one class may be summarized by the statement that a ferryboat is essentially a portion of a plant, whose design has to be carefully considered in regard to other portions with which she has to work in intimate connection. This condition is one not generally of great importance in marine work, and, therefore, apt to be overlooked, or insufficiently studied, in the design of ferryboats. The climatic conditions of the route, and the class of travel will influence the whole design of the superstructure and may entirely modify its character. The shape of the hull will be designed for a certain speed. This speed may depend upon the length of the route and the amount of travel over it, and, to a certain extent, upon the difficulties of navigation thereon. In such crowded waterways as the East River and the lower Hudson, the safe limit of speed is very quickly reached. But even there it varies with the manœuvering qualities of the boat, and especially with her backing and stopping power. The financial prosperity of the route will also have its influence. The power to successfully meet ice cannot be neglected on a route in northern waters. The tendency of the traveling public to concentrate upon the bow of a ferryboat causes these vessels to be generally trimmed by the head, and will force the designer to the use of a full load water line to minimize the bad effects of this undesirable manner of loading. Ease of form will naturally be sought in the shape of the buttock and diagonal lines, and the resulting form will generally give a good bow for ice work. A successful boat must combine easy handling, steadiness, comfort, economy, and adaptability to its special work, including speed, safety, and the comfort and beauty of its passenger accommodations. The designer will, of course, attempt to give his construction as much outward beauty as the ungainly structure will admit of; but this has little or no influence on the work of the boat or on its earning capacity.

A maximum of all the qualities above mentioned cannot, of course, be combined in any one vessel. The consideration to be given to each is a question for judgment in each individual case; and the experience of the route, to be obtained from those who have been employed on it, will be indispensable. But, above all things, whatever type is adopted, the construction should be reliable and should require a minimum of repairs. It is desirable that repairs, when necessary to take care of ordinary wear and tear, or when caused by accidents, should be carried out in the shortest possible time and at the least expense. With these demands, however, go also certain privileges (if I may use the word) that the designer of a ferryboat may avail himself of, and which are not usually enjoyed in other marine work. The hold of a ferryboat not being used for passengers or freight, has to accommodate merely the motive power and auxiliary machinery, with the incident stores of water and coal, and such safety appliances in the way of bulkheads as may be deemed requisite. There is no special need of concentration or for compactness of design. The openings through the deck, however, should be kept as narrow as possible, in order not to unduly diminish the deck space available for teams. The length of such openings, though, is of minor importance. The facilities for loading fuel should be such as would cause as little trouble and delay as possible in coaling up. In the general arrangement of the machinery, accessibility, reliability, and ease in manipulation cannot be lost sight of.

PASSENGERS CROWDED ON BOW OF FERRYBOAT, NORTH RIVER, N. Y.

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Any limitation to the depth of shaft may become a serious matter; and this arises sometimes in an unforeseen manner. The racks which run out into the water at the ferry landings, as usually built, consist of piling tied together by stringers, faced with heavy planking, forming a springing fence, which, from the requirements of the service, often has to absorb considerable energy. The footing for these piles is usually in mud; and if to attain the requisite depth, such an amount of this has to be removed as to render this footing insecure, the trouble and expense of rack maintenance may be so increased as to more than destroy the advantages to be gained.

After stating his problem, the designer will find that the first question for solution will be the manner of applying his motive power to propulsion. In other words, whether he should use side wheels or propellers. In the former case, a choice between feathering and radial buckets will have to be decided; while in the latter, the first question will be between single ended and double ended propulsion. On most routes this latter question will be decided by the conditions themselves, in favor of the double ended system. The advantages of screw propulsion over side wheels are: the removal of the paddle box from the space usually assigned for passengers, and the great improvement thereby made in the accommodation and the ease of ingress and egress. There will be a great gain, too, in backing and stopping power. For equal horse powers, the first cost will not vary greatly. As will be subsequently shown, in screw propulsion—as used in the Bergen of the Hoboken ferry and her successors—the power of the engines cannot be as efficiently applied to propulsion as in the case of paddle wheels. On the other hand, the engines themselves will generally show a decrease of consumption of steam per horse power, while the boilers will yield about equal results. The race from the propellers of the screw boat will scour out the middle of the slip without much affecting the footing of the piles and will practically do away with the necessity of dredging. There can be no question of the superiority of the screw in ice work; and it is certainly a great favorite with the traveling public. It requires a different shape of hull. This shape will increase the resistance through an increase of wetted surface, and peculiarities of form. A screw boat will generally steer better. This advantage is partly due to the fact that the center of thrust is below the effective center of resistance to forward motion, and the couple thus created has no tendency to depress the bow. In the side wheels the contrary is generally the fact; and the sidewheel boat in consequence will generally bury her head, while the screw vessel will tend to run out forward and squat aft. As ferryboats have their lateral area symmetrically distributed about the midship section, a tendency to bury the bow is apt to move the center of resistance to steering, ahead of the center of gravity; and the vessel is, therefore, as far as steering is concerned, in a position of unstable equillibrium; the slightest departure from the course giving rise to a tendency to increase the shear to that side. In a screw boat under way, the tendency to squat aft will generally keep the center of resistance behind the center of gravity. Her condition is then one of stable equillibrium. The speed of rotation of the engine, together with the frequent stopping, backing, and steering will render it generally inadvisable to attach any pumps directly to the main engine of a screw vessel. For the consequent complication in the shape of an independent pump plant, the screw vessel will have the advantage of a decreased load on the main engine and a vacuum always ready at starting. If a screw engine be selected as the most suitable type, the judgment of the designer must be exercised in deciding upon the degree of expansion desirable. In some designs, the advantage of two high pressure cylinders, acting on cranks at 90 degrees, for prompt backing, has led to the adoption of double compound engines; and the tendency has been not to repeat the triple expansion engine, used in the ferryboat Bergen.

If the side wheel is decided on, the first question will be, whether the ordinary American practice should be followed in adopting a beam engine. The wonderful persistency and long life of this type of design, which is certainly the oldest extant form of the marine engine, fully justify the statement that the system possesses advantages. Its usual form gives wonderful economy for a single expansion engine; its ability to run, and run smothly, with grave defects in alignment; the fact that it is thoroughly well understood by most American engineers and mechanics; its simplicity, accessibility, its economy in repairs, and its ability to satisfactorily operate its own air pump, are strong arguments in its favor. Whether its use as a compound will yield satisfactory results in ferry service, is still an unsettled question. It possesses one great defect, its liability to stop on the center. Even with the greatest care this risk cannot be entirely avoided, especially in ice. Many engineers will recall the trouble and difficulties incident to a prolonged fight with ice in a beam engine boat. In common with all side wheel designs, the wheels are more subject to damage by ice or floating wreckage than screw propellers; they are, however, more easily and more cheaply repaired when damaged.

I know of no attempt to use the oscillating or side lever engines in ferry service; and their use seems to promise no special advantages. The inclined engine, however, has received considerable attention. In the days of single expansion, one-cylinder engines, it was generally considered inferior to the beam engine in ferry work. In the Garrett and Wiman, of the Staten Island ferry, this engine, in the compound form, has been tried under adverse circumstances, and, on

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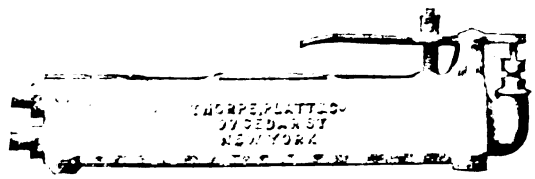
the whole, has given good results. It is very doubtful, however, whether the advantages of a smaller diameter and greater propulsive efficiency in the feathering paddle wheel, is sufficient to counterbalance the disadvantages due to the greater complication of machinery and the difficulty of securing equal efficiency in both directions. Whatever design be adopted, except in rare cases, equal efficiency in forward and backward motion must be constantly in sight. In this connection, too, the signaling gear must be such that the engineer will always know in which direction the pilot desires him to go. The beam engine as usually arranged, avoids this difficulty, from the fact that the engineer's station is on the main deck, and he is thus made aware of the direction in which the vessel is being navigated, in a far better way than possible in a system of signals. Whatever signals be used, should be simple, direct, and absolutely certain in their action. Their failure at any time will put the boat in imminent risk. In deciding on a type of engine, the amount of time that the vessel is actually under way—to which attention has already been drawn—should be carefully considered; and the economy in fuel of the various types under consideration should be carefully compared, proper allowance being made for the increased charges, due to first cost, depreciation and maintenance, which will generally be found to attach to the more economical design. The question of weight is generally not of the first importance. It affects, however, the punishment which the boats will inflict on the racks; and as the maintenance of the latter is a large item in ferry expenses, too free a hand should not be used in appropriating displacement. Under the usual conditions, the load of the vessel, both in superstructure and machinery, and passengers, will be distributed over a considerable length, and with metal hulls, ample longitudinal strength will usually be found; but in screw boats, rigidity to preserve the alignment of the long shaft must also be provided. If the vessel be double-decked, the stability ought to be carefully investigated, assuming as usual the most unfavorable conditions. A considerable heel in these vessels is likely to produce a panic among the passengers, and the avoidance of such inclination, and not the absolute safety from capsizing, is the result to be sought. The auxiliary machinery usually consists of the pumping plant, steering engines, electric light engines and dynamos, and heating and ventilating engine. Of the former, little need be said, as they differ in no wise from ordinary marine practice. Heating and ventilating, however, present a difficult problem on account of the shape of the cabins. The most approved method has been the forcing of hot air by fans through outlets, placed in the upper portion of the places to be heated, and escapes for the foul air at the floor level. The improvement effected by this method has been very marked.

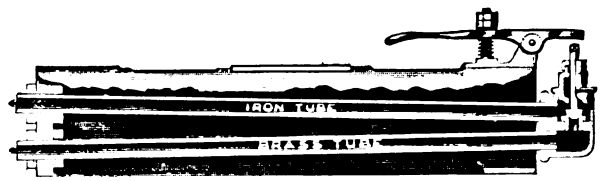
IMPROVED APPARATUS.

The Geipel Steam Trap.

The Geipel Steam Trap, manufactured by Thorpe, Platt & Co., of 97 Cedar street, New York possesses some features of especial interest to marine engineers. In the illustration the lower, or brass pipe, is connected to the steam pipe, the upper, or iron pipe, forming the discharge. When cold, the brass pipe is contracted, and the valve-box is drawn down, leaving the valve free to open. When steam enters the brass pipe it causes it to expand, this raises the valve-box and valve, the stem of the latter comes in contact with the lever, the seat closes onto the valve, and the trap is shut. To blow through it is only necessary to press down the lever. The valve may be readily examined by unscrewing the cap, and the whole trap may



EXTERIOR GEIPEL STEAM TRAP.



SECTION GEIPEL STEAM TRAP.

be taken apart and put together again in less than five minutes. The shape of the trap is handy for marine purposes. It may be conveniently fixed on the engine columns, or bulkheads, vertical or otherwise, and drains the main steam pipes, the valve casings, the steam jackets (if any), or branch pipes to auxiliary engines, keeping these important parts clear of water without the loss of dry steam. It is claimed that there is a distinct economy in steam, and also in packing, which is found to last longer when this trap is used. It is further stated that as less water is lost through the glands, so there is less fresh water required on board ship. This Steam Trap has been used in numbers of steamships, and in some for the United States Government. Geipel Steam Traps were fitted in the S. S. Inchmona, the engine trials of which were the subject of much interest here and abroad. Many leading shipbuilding firms in Great Britain have adopted it, and The William Cramp Ship & Engine Building Co. has used the trap. The accessibility of the trap will be apparent to all engineers. The makers guarantee it steam tight, and it has a large capacity in proportion to its size.

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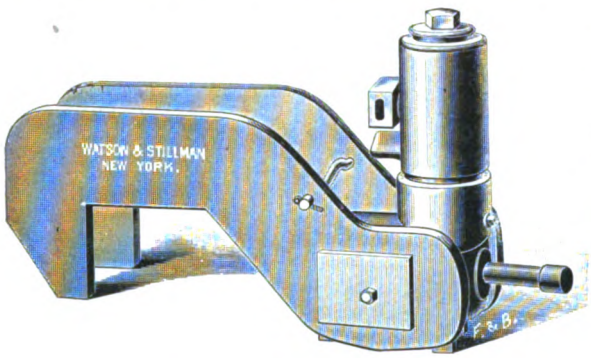
Hydraulic Coupling Belt Forcer.

A coupling bolt forcer is one of that class of tools which, while not of everyday use, is of the greatest possible value when its services are required. In the hurry of a break-down repair, such a tool is worth much, for when it is properly adjusted in place and the pressure applied, something has "got to go." The Watson & Stillman Hydraulic Machinery Works, of New York, has produced a compact coupling bolt forcer, which is here illustrated. This is specially intended for

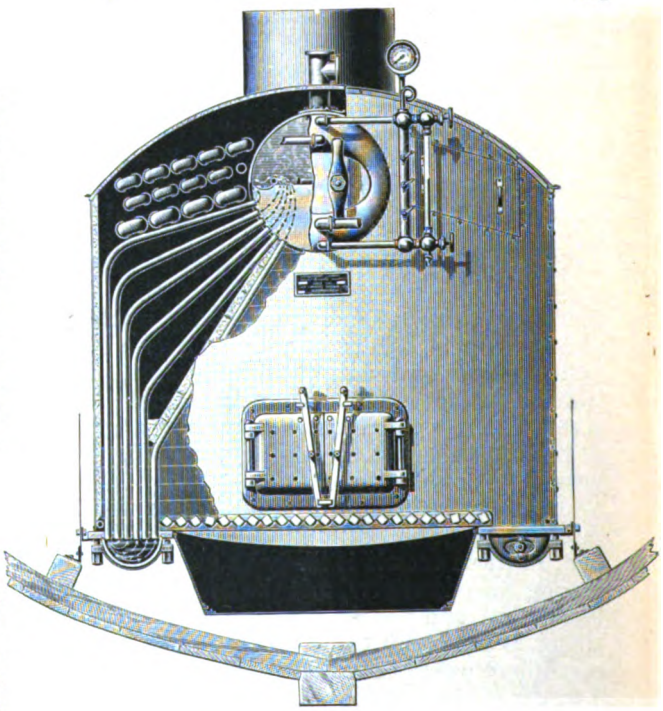


FOR USE ABOARD SHIP.

use in the shaft alleys of the larger steamers, where there is very limited room to work, and the coupling bolts must be both large and tight. The working action of the tool is the same as in the well known hydraulic punches of the company, except that there is no lever return action to the ram. A rapping bolt extends through to the rear of the cylinder, so that if the bolt does not start with the maximum strain of the tool, a jar may be given by a blow on the pin. The side plate-hooks are made to suit the shaft flanges. The tool shown exerts easily a strain of 45 tons. The ram has a motion of 3 in., and the greatest distance of ram to inside of hooks is 11 in. The weight is 200 pounds.

Seabury Water Tube Boiler.

An improved form of the Seabury water tube boiler has been designed by the Gas Engine and Power Co., and Charles L. Seabury & Co., Morris Heights, N. Y. An illustration of this is shown as fitted and placed on a vessel. It is a very compact form of steam generator and, indeed, the builders claim to furnish more heating surface for the same floor space occupied than any other boiler. The selection of material and work of construction is very carefully carried out. The drums, which are rolled to shape, have the rivet holes drilled through the lap, and are tested to a pressure of 500 pounds. The tubes, which are bent to the required shapes, are tested to 1,000 pounds pressure. The half manifolds at the sides of the furnace are made by welding a head in each end of a piece of lap-weld iron pipe, cutting through the center lengthwise, and planing the edges to fit a groove in the under side of the tube plate. The joint is made with asbestos wick in the groove, the half manifold being drawn up to the packing by steel bolts and straps. The heads of the bolts are countersunk, and they are fitted with cap nuts, so that a smooth joint is secured, with no part of the bolt threads exposed. The tubes are expanded in place at both ends. It will be noticed the furnace is surrounded by water tubes, spaced between diameters a distance equal to the diameter, so that the gases have free passage the entire length of the tubes. A firebrick baffle plate is inserted between the tubes, over the first row. The feed water heater is placed on top of the rows of inclined tubes, where it receives a considerable portion of the heat, which passes up between the tubes and which would otherwise be wasted through the stack. Shaking grates are provided which can be used either for hard or soft coal, or for wood. The builders claim a very vigorous water circulation in this boiler. All the tubes deliver below the water line in the steam drum. The direction of the water is upwards in all the



BOILER FITTED IN A VESSEL.

rows except the outer. Through these the water is returned to the bottom of the boiler, the entire length of the drum, each tube carrying its own water uninfluenced by any other. At no point does the water have to flow more than 12 to 18 in. to get from the up-flow to the down-flow. It is claimed that it is not possible to drive the water out of the tubes by fire, as the more intense the heat the greater proportionately is the circulation. There are good facilities for inte-

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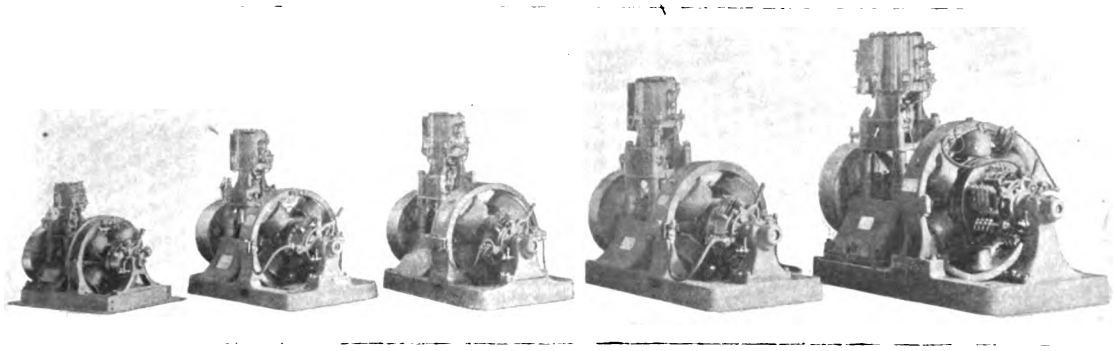
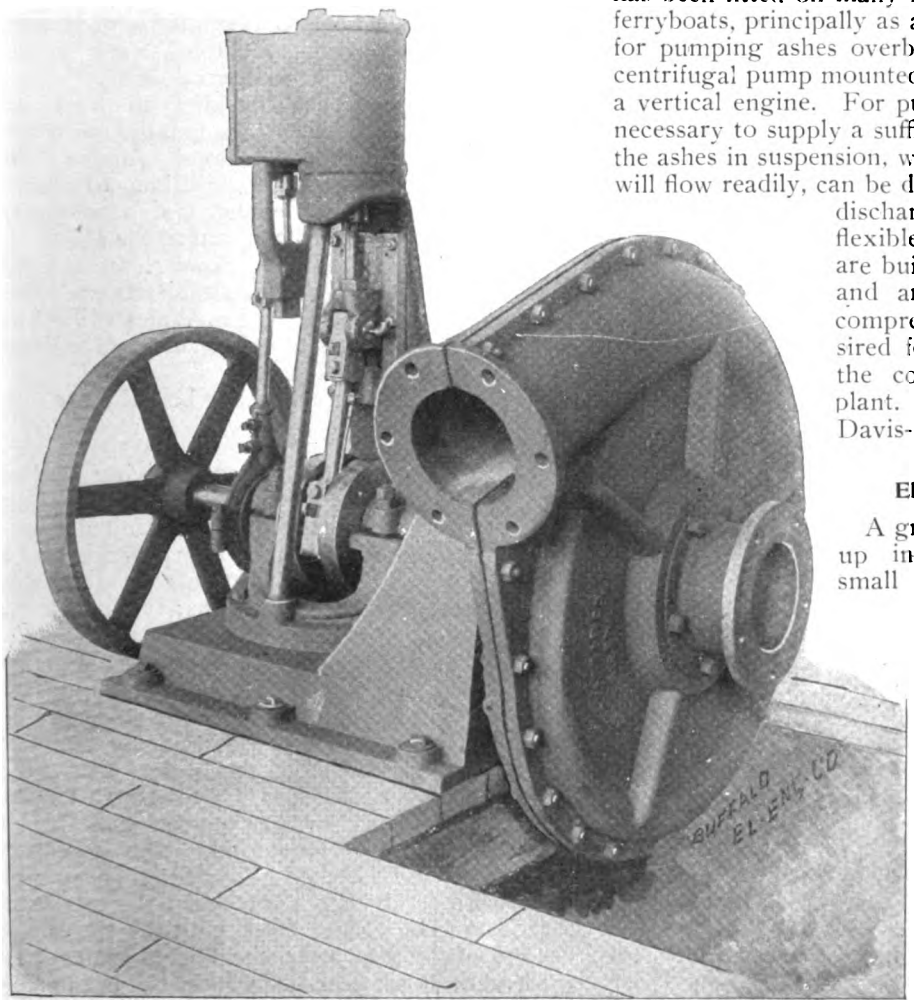
rior cleaning in the shape of man and mud holes. A steam pipe is also conveniently fitted between the tubes and water casing, so that the tube plate, and lower end of the tubes, can be freed from ashes and soot when the boiler is working. Expansion and contraction were carefully considered in the design, and all material used passes severe tests.



GENERAL ELECTRIC COMPANY'S SETS FOR MARINE USE.

Centrifugal Pump and Engine.

A direct connected centrifugal pump and engine is one of the most convenient of the engine room auxiliaries. It lends itself to a variety of useful operations, does not occupy much space, is simple in its construction, and easily kept in repair. The outfit shown in the accompanying cut has been fitted on many modern steamships and ferryboats, principally as a circulating pump, and for pumping ashes overboard. It consists of a centrifugal pump mounted on the same base with a vertical engine. For pumping ashes it is only necessary to supply a sufficiency of water to hold the ashes in suspension, when the mixture, which will flow readily, can be drawn, or forced up, and discharged through piping or flexible hose. These machines are built in a number of sizes, and are also furnished with compression pump when desired for circulating through the coils of a refrigerating plant. They are built by the Davis-Farrar Co., of Erie, Pa.



DIRECT CONNECTED CENTRIFUGAL PUMP AND ENGINE.

Electric Light Plants.

A great demand has sprung up in marine practice for small direct coupled engines and generators for lighting purposes. The principal requirements are compactness, light weight, simplicity of construction, freedom from vibration and noise at high speed, and perfect regulation as well as durability, and low first cost. The sets here illustrated are manufactured by the General Electric Co., of Schenectady with these in view.

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These sets are built in sizes varying from 2½ K. W. to 25 K. W. As both engines and generators are manufactured by one concern, there is the greater probability that the fit and alignment are perfect, the finish uniform, and the tests accurate. The engine is simple; it has but one valve driven direct from the eccentric pin of the governor. The set is compact, the engine having a short stroke, and the armatures being specially wound. Both height and length of the sets is reduced to a minimum. The engine bed lengthened carries the generator, and although the appearance is somewhat massive, the bed is so carefully cored out, that without sacrifice of stability, the weight has been brought down to about one pound to 3½ watts. The engine bearings are self-aligning and self-oiling. The coupling between the armature shaft and engine crank is a split sleeve, which allows of easy removal of the armature. The governor is compact, with but few moving parts, which can give practically no trouble, or wear out. All of the generators are four pole 110 volt machines, with the exception of the 25 K. W. generator, which has six poles and a full load voltage of 125 volts. The greatest floor space occupied is 80 in. by 47in. by 66 in. high. The generators combine all the well known features of the General Electric machines, and the rating given to each has been calculated on a most conservative basis. The illustration shows a full line of single cylinder sets—2½ K. W., 7 K. W., 10 K. W., 15 K. W., and 25 K. W. The single cylinder engines are economical. They show as low as 28 pounds of water per I. H. P. hour non-condensing, and 23.5 pounds per I. H. P. hour condensing, using steam at an initial pressure of 80 pounds, direct from the boiler. These results have been obtained by an exact series of tests in sets above 10 K. W. capacity. The smaller sets are, of course, less efficient, but yet well up to the best standards.

NEWS AND NOTES.

The 1897 session of the British Institution of Naval Architects was opened in London on April 7th, with the Earl of Hopetoun in the chair. A number of very valuable papers were read by eminent men. Among these were papers by Engineer-in-Chief, A. J. Durston, R. N., on "The Recent Trials of the Cruisers Powerful and Terrible;" Rear-Admiral C. C. P. FitzGerald on "Water-tube Boilers in Warships," a digest of which will be found elsewhere in this issue; A. G. Ramage, on "A Mechanical Method of Ascertaining the Stability of Ships;" Capt. Lord Charles Beresford, R. N., "On the Fighting Value of Certain of the Older Ironclads if Rearmed;" Hon. Charles A. Parsons on "The Application of the Compound Steam Turbine to the Purpose of Marine Propulsion;" J. Macfarlane Gray on "The Accelerity Diagram of the Steam Engine" and a "Note on the Geometry of Stability;" Prof. Vivian B. Lewes, F. C. S., F. I. I., on "Acetylene and its Probable Future Afloat;" Prof. Wm. Beardmore on "Nickel Steel as an Improved Material for Boiler Shell-plates and Forgings;" Herr F. von Kodolitsch on "Application of Electrical Transmission of Power in Marine Engineering and Shipbuilding. Appropos of Mr. Beardmore's paper an article on the construction of a nickel steel boiler will be found elsewhere in this paper. In the paper on Nickel Steel by Mr. Beardmore he foretold a very extensive use for this material in the future, a use, in fact, the progress of which was only retarded by the price of this material, as three per cent of nickel added $45 a ton to the market price of carbon steel.

The most remarkable paper, perhaps, which was read at this meeting was that of the Hon. C. A. Parsons relating to the small steamer Turbinia. This vessel displaces 44.5 tons, and is fitted with engines of 1,576 horse power which weigh only 8,056 pounds. A speed of 31.01 knots was attained, the steam consumption being only 15.86 pounds per hour. A vacuum of 13.5 pounds was maintained at 2,100 revolutions a minute. The machinery weights, including water in the boiler and hot-well, were 48,400 pounds.

The Institution has decided to hold an International Congress in commemoration of Queen Victoria's Diamond Jubilee. It is the desire of the Association to make this gathering a notable one, and accordingly special invitations have been sent to the Ministers of Marine of all the great powers, and to the American Society of Naval Architects and Marine Engineers. The Prince of Wales will act as honorary President of the Congress, and will deliver the speech of welcome.

The meetings will probably be held early in July.

British smelting interests are deriving a good deal of satisfaction from an inspection of the pig iron output totals for 1896 of the United Kingdom and the United States, with Germany as a sort of happy sequel. The totals for 1896 are, United Kingdom, 8,750,000 tons; United States, 8,623,100 tons; Germany, 6,450,000 metric tons. The figures for the United States are 126,900 tons behind those of the United Kingdom, and show a falling off from the previous year of 823,200 tons. The conditions were decidedly the other way in 1895, for the totals for that year were: United Kingdom, 7,703,000; United States, 9,446,300 or 1,550,700 tons more than the United Kingdom. The top figures for the United Kingdom, prior to 1896 were reached in 1883, when the total was 8,529,000 tons. Since 1890, with the single exception of the year 1894, the United States kept the lead until last year. Germany has been making steady advances, having in 1880 turned out only 2,729,000 tons.

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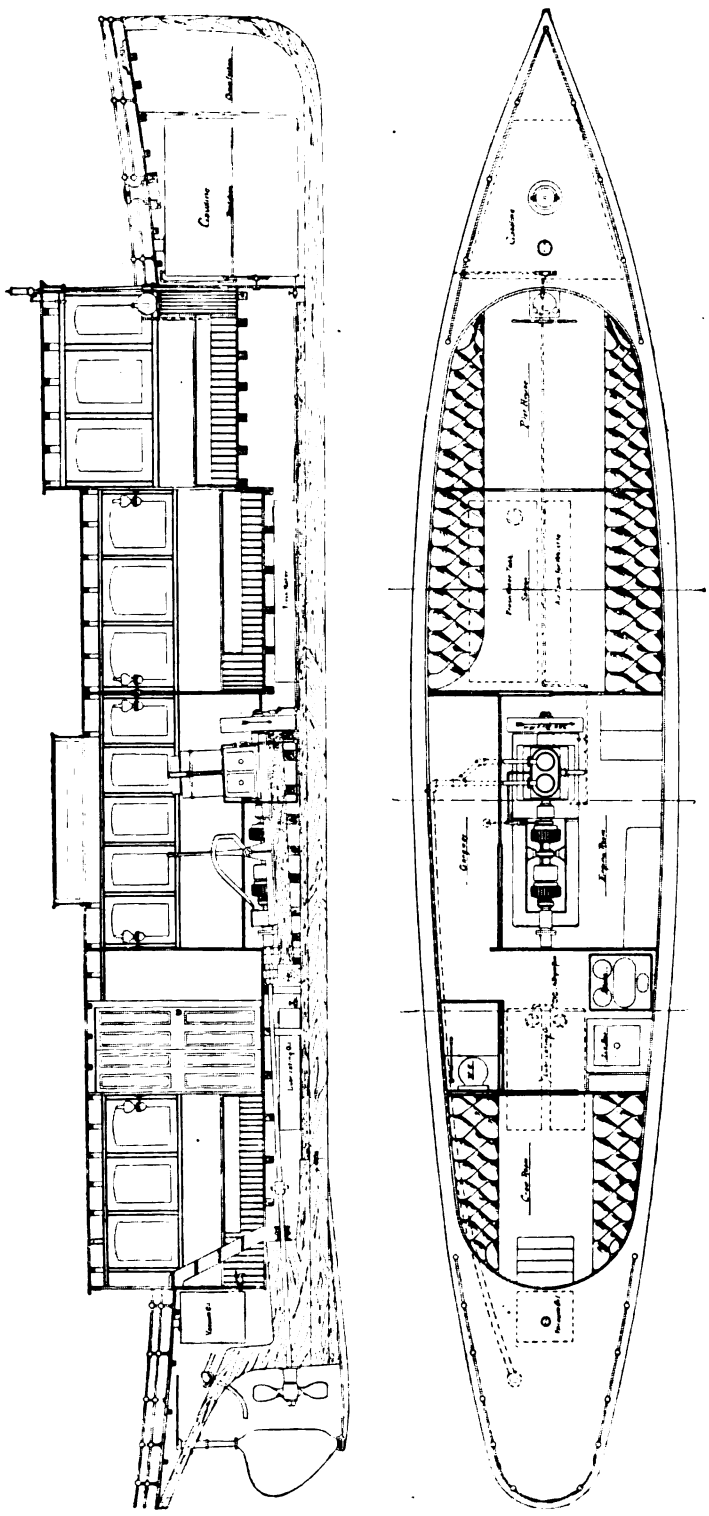
YACHT HELENE PROPELLED BY GASOLINE MOTOR.

The yacht Helene, owned by the Otto Gas Engine Works, of Philadelphia, is an interesting example of a motor boat built for cruising in rough water. She is 53 ft. long, 9 ft. beam and has a mean draught of 4½ ft. The hull is of oak and yellow pine, very substantially put together, and the deck planking is cedar. The saloon, and pilot house, and cabin are finished in mahogany, while the engine room is finished in maple. The exterior appearance of the boat is very handsome, showing graceful outlines, which are set off by the artistic combination of painted and polished woodwork and brass fittings. In the saloon there is sleeping accommodation for seven persons. There is also kitchen and pantry accommodation, and crew room. The propelling machinery consists of a 50 H. P. Otto marine engine, using gasoline. This is stored in the fuel tank forward, which holds 600 gallons. Pipes are laid to the engine room, through which the supply is drawn by a small pump. The motor is fitted with an electric ignition, so that there is no possibility of contact of the fuel with an open flame, and the trouble of handling inflammable oil for heating ignition tubes is avoided. It is also fitted with a self starting device which obviates the necessity of turning the fly wheel or pumping up a charge for the engine before getting in motion. The exhaust of the engine is led into an exhaust pot, and from there carried out underneath the water thus getting rid of all noise and smell. The rate of consumption of fuel is said not to exceed one-tenth of a gallon per indicated horse power per hour. The supply in the tank is sufficient for an extended cruise. In the form of motor used in the Helene the power is transmitted to the propeller by reversing gears. The weight of the engine and reversing apparatus is 2½ tons. The usual method employed by these engine builders is to use a reversible propeller. By this the speed of the boat can be reduced to a minimum by turning the blades to incline at a very small angle. In narrow passages, and when passing through locks, this is convenient for keeping steerage way on the boat. In smooth water, the Helene has attained a speed of 14 miles an hour. Under ordinary conditions an average of 11 to 12 miles is maintained. The Helene has made the trip from New York to Philadelphia on the outside in a very satisfactory manner.



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Letters and other mail matter can be sent to our care and will be forwarded or held until called for, as desired.

Communications on matters of interest to marine engineers, for insertion in the correspondence department, are solicited. These, wherever possible, should be supplemented by rough sketches or drawings, which will be reproduced if necessary to illustrate the subject, without cost to the writer.

Full names and addresses should be given, but publication of these will be withheld where requested.

The epigrammatic letter of Mr. Charles H. Cramp, which is printed in part on these pages, is as vigorous a protest against the supineness of the American shipping interests as has yet been heard. There has been a remarkable want of unanimity and decisiveness among the marine interests of the country. Endless discussions of the subject have been undertaken and nothing has been accomplished. The advocates of various systems of Federal support loudly claim exclusive advantages for their systems, and pass resolutions, which are neatly printed and distributed. It is not to be supposed that any system could be adopted which would prove perfect in practice. Yet if a compromise plan was agreed upon, understandingly, and action taken, no matter how defective it might prove to be, it would be progress. The Britisher adopts different methods in his treatment of matters bearing on the nation's prosperity. He uses mass meetings, and resolutions to solve the question of relief for the starving in India, or aid for the revolutionists in Crete. Where the supremacy of British trade is concerned, however, an upper room conference in Lombard street is worth a dozen Hyde Park demonstrations. As to the disposition to let Congress take the initiative. Is it to be expected that a body, many of whose members never saw an ocean vessel until they came East to take office, will be so informed on the question as to act with enthusiastic intelligence? If American shipping interests are to be conserved the parties in interest must carry through the work. The trading classes will not take the initiative. They do not give the subject attention. Probably they think it does not specially concern them. If the merchant has his goods delivered, safely and cheaply, he does not care who owns the ship. Traffic will always flow along the lines of least resistance. Mr. Cramp refers to the activity of British consular officers, in foreign countries, in circulating reports derogatory to American shipbuilding skill. The average foreign shipowner is a man of education and intelligence, and could hardly be largely influenced by reading the sensational blatherskite about ships which is printed in so many newspapers. Indeed, if all the perfecting presses in the world worked overtime from now until doomsday, their run-off would not have a fraction of the weight, which the actions of Messrs. Higgins, Goelet and Bennett have, in discrediting the American builder. Here is a good chance for comparison with the Britisher. Does he go abroad, even for what he cannot get at home? Does he place orders here for sailing yachts which will come in first in a race? His views on the subject were expressed rather forcibly when a Scotch builder sent to Germany for some heavy forgings for certain well known ocean steamships. Even lately the installation of American built engines in an English electric light plant caused the lion to growl deeply. Will the nation which has never known defeat in peace or war respond to foreign progression with resolutions only? We believe not.

In this number there are published illustrations and descriptive matter of the first nickel steel boiler built in the United States, or probably in any country. The use of this material for boiler construction is due to the enterprise of the Bureau of Steam Engineering of the Navy. It required some courage to plan this experiment, and a good deal more to carry it through, owing to the practical difficulties narrated. Many who are interested in this class of work will, doubtless, consider this experiment of little value to manufacturers who have to build boilers at market rates. But the possibility of such an experiment creating a change in practice should not be lost sight of. Should the results be satisfactory, the government will not only be in possession of valuable knowledge in the construction of improved apparatus, but will have conferred a substantial benefit on the mercantile marine interests, by showing where economical gains may be made. The material is expensive, but should a large demand be created for nickel steel, it is not unreasonable to suppose that the price would be reduced. Government practice opens the way often for the private individual to secure substantial benefits without the cost of experimentation. A notable example of this is the universal use of heavy steel forgings in engine building, which, when first introduced were considered luxuries for the purse of a nation only.

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MR. CHARLES H. CRAMP ON THE MERCHANT MARINE.

The views of Charles H. Cramp on the Merchant Marine problem are expressed in a paper read before a conference, recently, in the committee room of the Senate Committee on Commerce. This paper in part is here given:

Mr. C. A. Griscom, Chairman of the Sub-committee on the Merchant Marine.

SIR:—We have to deal with real facts and actual conditions. The interests of ship owning and ship building are identical, because no nation can successfully own ships that cannot successfully build them.

No nation can either build or own ships when, unprotected and unencouraged, it is brought in competition with other nations that are protected and encouraged.

This is the existing condition of the ship owning and ship-building interests of the United States.

The resulting fact is that the enormous revenue represented by the freight and passenger tolls on our commerce and travel is constantly drained out of this country into British, German, and French pockets, in the order named, but mainly British; while the vast industrial increment represented by the necessary ship building inures almost wholly to Great Britain.

For this drain there is no recompense. It is sheer loss. It is the principal cause of our existing financial condition.

So long as this drain continues, no tariff and no monetary policy can restore the national prosperity.

The Engish steamship is a foreign product, and its earnings, which we pay, are a foreign profit.

No sane man will argue that a foreign profit on a foreign product can be a domestic benefit.

Add to this the fact, equally important, that the carrier of commerce controls its exchanges, and the condition of commercial, financial, and industrial subjugation is complete. Such is our condition today.

Great Britain has many outlying colonies and dependencies.

The greatest two are India and the United States.

She holds India by force of arms, whereby her control of that country costs her something. She has to pay something for her financial and commercial drainage of India.

She holds the United States by the folly of its own people, whereby her control of this country costs her nothing. She has to pay nothing for her financial and commercial drainage of the United States.

But the amount of her annual drainage of gold from the United States far exceeds that from India.

Therefore, the United States is by far the most valuable of all the dependencies of Great Britain.

In the relation of England to India there is something pitiable because India is helpless.

In the relation of the United States to England there is nothing that is not contemptible, because it is the willing servitude of a nation that could help herself if she would.

England is wide awake to these conditions, and keenly appreciates their priceless value to her.

The United States blinks at them, half dazed, half asleep, insensible of their tremendous damage to her.

England, clearly seeing that, in this age more than ever before, ocean empire is world empire, strains every nerve to perpetuate her sea power and exhausts her resources to double rivet the fetters which it fastens upon mankind.

In recent years Germany on a large scale and in a systematic way, and this country on a small scale and in a spasmodic way, have put forth efforts in the direction of sea power.

England instantly takes alarm. To her the growth of any other sea power, even if its scope be comparatively small and its extent comparatively feeble, is a peril second only to the landing of an invading army in Kent.

England is determined that she shall be not only the supreme sea power, but also that except within limits set by herself there shall be no other sea power at all.

She will tolerate the growth of any other sea power only so far as the point at which it begins to effect her naval supremacy or dispute the ocean monopoly of her merchant marine.

The moment any other national aspiration toward sea power reaches that point England must be prepared to crush it.

She will crush it by intrigue, by cajolery, by treaties, if she can. She will crush it by preponderating force if she must.

English officials abroad, from Ministers and Consuls down, industriously reproduce in the newspapers of Japan, China, Chile, Argentine, and Brazil the misstatements of the English press about American vessels.

The British Post Office delays the American mails for days in the slower ships of the Cunard line rather than send so much as one letter by the American line.

Our Post Office responds by liberal allotments of its European mails to all the British lines.

The result of all this is that while this country has never known such industrial stagnation and such financial distress, England has never known such industrial activity and financial prosperity as now.

To the English estimates for the current year for further increase of her navy amounting to eleven millions nine hundred and five thousand pounds sterling (£11,905,000, say $57,334,500) and a programme involving 108 new ships in all stages between laying down and completion, the United States responds by a sudden halt in even the comparatively feeble programme fitfully pursued since 1885, and a flat collapse of the policy of the new navy as a whole.

To the 1,380,000 tons of new merchant shipping built by England during the past year, what will be the response of the United States?

Now the future lies wholly in the hands of Congress.

From that quarter comes no sign.

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CORRESPONDENCE.

[We do not assume responsibility for the opinions expressed by correspondents.]

Pointers for the Information of Water Tube.

Your correspondent, "Water-Tube," in the April number of your very interesting paper, is quite right in the assumption that the water tube boiler needs a different kind of treatment, and more watching than the Scotch boiler. He will, perhaps, agree that his new triple, or quadruple expansion engines, and the vast array of auxiliaries under his charge require more and a different kind of attention than his old compound engine, and the simple plant of only a few years back.

The water tube boiler is a later development and will also require more care than the older slow steaming boilers. With some types of this class of boiler the firing will undoubtedly have to be different, this being largely caused by the fact that the design of the boiler gives a grate, in some cases 9 ft. wide, by from 7 ft. to 8 ft. long. Such a grate cannot but be difficult to manage. With grates of the ordinary dimensions, he will find but little difference in management needed. The feed in all water tube boilers does need close attention. This is necessarily so from the fact that a smaller body of water is carried in the boiler, and a higher rate of evaporation called for. All such boilers should be fitted with an auxiliary feed pipe, and have a feed water regulator to control the main feed. Such an automatic feed apparatus is being used even in the boilers in the large torpedo boat destroyers built abroad, and in boilers developing 1,800 H. P. each, where the utmost forcing is necessary, and always with the greatest success.

Given a good feed regulator, large top drum, and good circulation in his boiler, and "Water-Tube" need not fear for the result. E.

Owing to the comparatively small quantity of water in water tube boilers, as compared with "tank" boilers, the steam is apt to rise and fall more rapidly than in the former. Do not, therefore, cover your fire entirely with fresh coal at any one time, as the steam will fall rapidly before the fresh fire is burned through. You should fire "little and often"—the quantity depending upon the size of the boiler. It is also best to use coal of small size. Open your furnace door and throw a shovelful onto each thin spot in the fire, letting each shovel full be surrounded by bright fire as far as possible. This does not knock the steam down to any extent and the bright fire will also burn the gases arising from the fresh coal thrown in. When you are obliged to clean your fire, do not disturb it till you have gradually built up a thicker fire, so as to have something left after cleaning. Do not clean all the fire at once, but clean part at a time, and get that part in good working order before you start on another section. You will find an air cock on all feed pumps, whether attached to the engine or independent, for the purpose of relieving the pressure on the discharge valve, letting the air out, and starting the pump when it stops feeding. You will find it a great improvement to take out this cock and run a small pipe from the same outlet in the pump to a point over the hot well, or filter. Then screw this cock on the end of the pipe. By leaving this cock open a trifle, it will discharge all the air which accumulates in the pump and will also discharge some of the water into the hot well. You will find that you can regulate the feed of the boiler with considerable accuracy by the use of this cock alone (of course, we are referring to pumps used in connection with surface, or keel, condensers) as, if there is too much water in the boiler, you can gradually allow it to accumulate in the hot well by opening this cock widely, and thus less water will be forced into the boiler. It is also best to regulate this cock in such a way that the pump will never take all the water out of the hot well, and thus suck air. When an independent pump does not get any water through the suction it is apt to "race" or "run away," and this necessitates frequent attention to the pump throttle.

THE ROBERTS SAFETY WATER TUBE BOILER CO.

Plan For Securing Oil Cups.

Possibly some of your readers may have been bothered with the cross head oil cups on the main engines, and our experience in this direction may be of interest. During many trips the cups fitted were constantly breaking off at the neck close to the base of the cup. The cups were heavy brass castings, with a small shank screwed pretty deeply, so that there was only a small diameter of metal left to sustain the weight of the cup. When the crank passes the centers the forked end of the rod gets a sharp jerk, and this snapped the cups right off, so that they flew about like base balls. Now we have them cast with a lug, and also screwed in in the old way. The base of the cup gets a good bearing on the cap of the brasses and is held by a small screw, which passes through the lug and fits a tapped hole in the cap. I am told that on some of the English boats the cups have square bases, and a hole at each corner for a screw. In my opinion oil cups are made altogether too heavy. If they were made of light brass stampings they would be just as strong, and not nearly so clumsy as the heavy cast cups. McM.

Deposits In Steam Cylinders.

We do not pretend to know it all, and we do not know what is the trouble with the cylinder oil used by your correspondent who signs himself "Transatlantic," but we think that he will find the use of ordinary kerosene oil (refined coal oil) in his cylinders will cut out the deposit, to which he alludes, and thus keep the cylinders clean and restore the elasticity of the piston rings. R.

In your April issue, under the head of "Correspondence," I notice a letter from "Transatlantic" regarding deposits in steam cylinders. This subject was presented to me some time ago for investigation. After several months' work upon the deposits I prepared a report which I send you. This is entitled, "The Analysis of Cylinder Deposits," and was originally published in "The Journal of Analytical and Applied Chemistry." THOMAS B. STILLMAN.

[The article referred to by Prof. Stillman will be found under a separate heading on page 29

An analysis of the substance sent by "Transatlantic" shows that it contains:

	Per Cent.
Water	4.80
Oil and organic matter	29.40
Sand	8.70
Iron	32.00
Copper	1.80
Tin	2.60
Zinc	5.30
Combined oxygen (by diff.)	15.40
	100.00

The iron exists in the deposits mainly as iron oxide, but particles of metallic iron, or steel, were seen. The other metals are, probably, largely in the metallic state. The cylinder oil which was used in the engine from which this deposit was taken was found by analysis to be mineral oil with a 6 per cent. admixture of animal oil. We would suggest that our correspondent procure a pure mineral oil, for by its use the trouble would, undoubtedly, be greatly modified.—Ed.]

Troublesome Feed Pumps.

I enclose a problem that I would like some of your readers to answer. I am running a triple expansion engine, exhausting into a surface condenser. My pumps are connected to the main engine, including air, bilge, circulating and feed pumps, all except the donkey, which acts independently. My problem lies in the feed pumps. They seem to be fickle about their action. At times they work well no matter how

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wide open the extra feed is, and at other times they refuse to pump at all. Our feed water is delivered to the boilers at a temperature of 128 degrees F.; our discharge water at 93 degrees F. when the temperature of the sea is 60 degrees. The pumps are single acting. Plungers are 2 in. in diameter and have a 24 inch stroke, have snifting valves on each pump between checks. Foot checks are set at ¼ inch lift, and discharge check at ⅛ in. lift. Hot-well is constructed so that the feed water runs to the pumps. When the pumps stop pumping with the snifting valves open, shutting the valves will sometimes start the pumps, but will cause the boiler check to become noisy. The valves are all ground, and fit nicely. There are no leaks around the suction pipes. The air pump has a vapor pipe. Another air-hole in the top of the hot-well also relieves its exhaust. I would be glad to read any suggestions from my brother engineers. TEXAS.

The Analysis of Cylinder Deposits.

BY THOMAS B. STILLMAN, M.SC., PH.D.

The deposits in steam cylinders, formed by the decomposition of lubricating oils, may be classified as simple or compound, depending upon whether the deposit is due to the decomposition of the oil alone or if foreign matters, carried over in the steam from the boilers, are also present.

In the former case, carbon, hydrocarbons, oils, and iron oxide are the principal constituents, whereas, in the latter, oleate of lime, carbonate of lime, and silica are often present in addition to the former.

The following analysis of a sample from a locomotive cylinder would indicate a simple deposit:

Moisture		2.28 per cent.
Oils soluble in ether.	Animal	10.54 "
	Mineral	11.23 "
Hydrocarbons insoluble in ether		47.97 "
Fixed carbon		23.73 "
Iron oxide		2.83 "
Undetermined		1.42 "
Total		100.00

And the one given below, of a deposit from the steam cylinders of a large stationary engine, would show that scale-forming material from the boilers had become a component.

Moisture		13.12 per cent.
Oils soluble in ether.	Animal	8.15 "
	Mineral	7.86 "
Soap		2.10 "
Hydrocarbons insoluble in ether		1.67 "
Fixed carbon		2.71 "
Oxides of iron (and aluminum)		6.81 "
Silica		3.65 "
Carbonate of lime		43.22 "
Carbonate of magnesia		10.17 "
Undetermined		0.44 "
Total		100.00

In many samples, I have found copper and zinc in the deposits, formed by the corrosive action of the liberated oleic acid from the animal oil upon the brass or composition bearings.

This corrosive action is very marked where a poor quality of lubrication oil, composed of animal or vegetable oil, is used; whereas a pure neutral mineral oil has no acid action at steam temperature. Oftentimes the statement has been made to me, when the deposit was given for analysis, "All of our lubricating oil is pure mineral oil; we use no other." And yet, upon analysis, lard oil would be shown in comparatively large amounts.

This is accounted for from the fact that while the consumer believes he is using pure mineral oil—which was sold to him as such—the manufacturer has introduced from 3 to 30 per cent of lard oil.

A large majority of the so-called "pure mineral" lubricating oils for cylinder use contain at least 3 per cent of animal oil; and it is the exception and not the rule to find a "pure mineral" oil for cylinder lubricating purposes.

An analysis of a deposit from the steam cylinder of a large freight steamer gave as a result:

Moisture		16.16 per cent.
Oils soluble in ether.	Castor oil	26.19 "
	Mineral	32.50 "
Fixed carbon		7.92 "
Copper		0.50 "
Iron oxide		25.10 "
Undetermined		1.63 "
Total		100.00

Pure mineral lubricating oil was supposed by the officers of the vessel to be the only lubricant used, and special care had been taken to secure it, but it appears that the engineer added a small amount of castor oil to the mineral oil, as, in his opinion, it made a better lubricant. The decomposition of the castor oil and liberation of the fatty acid was the primary cause of the deposit.

The action of the fatty acids upon the iron and metal bearings results in different products. That is to say, while the copper when present has generally been estimated as copper oxide, the iron may exist only as oxide or as metallic iron, or both. No doubt the oleic acid acts to form salts of these metals, but it is certain, in many instances, that when formed, they are immediately decomposed or partially so, and a resulting mixture formed that is somewhat difficult of analysis.

In the analysis here given, it will be noticed that the iron was found both as metal and as oxide:

Moisture		3.77 per cent.
Oils soluble in ether	Animal	21.27 "
	Mineral	19.60 "
Soap		traces.
Fixed carbon		10.90 "
Iron oxide		14.01 "
Iron		27.85 "
Lead oxide		0.82 "
Copper oxide		1.07 "
Undetermined		0.71 "
Total		100.00

It is very seldom that sulphates are found in cylinder deposits. When the lime and magnesia exist in amounts more than necessary to combine with the carbonic acid (combined) and sulphuric acid (combined) present, the excess may have united with oleic acid to form soaps insoluble in water.

In some instances the lead oxide and zinc oxide will be found as lead and zinc oleates, but in others, while they undoubtedly first existed as oleates, they had become decomposed, and the lead and zinc oxides would be found.

In the United Kingdom there is at present a revival of the scheme to construct a tunnel between Ireland and Scotland. Various routes have been talked of and the estimates vary from $30,000,000 to $80,000,000. It is believed by many that sufficient traffic could not be secured to pay interest on this sum.

The Hamburg-American line will celebrate its fiftieth birthday on the 27th of this month, the Company having inaugurated the service to America on that day, in the year 1847. For nearly ten years the service was maintained by sailing vessels. In 1856, however, the Company purchased the steamships Borussia and Hammonia. The last addition to the fleet is the monstrous steamship Pennsylvania which was fully described in our last issue. The fleet of the Company, exclusive of the Pennsylvania, consists of 55 steamships, with a dead weight capacity of 205,130 tons. More than a dozen new vessels are soon to be added, which will make an addition of nearly 120,000 tons.

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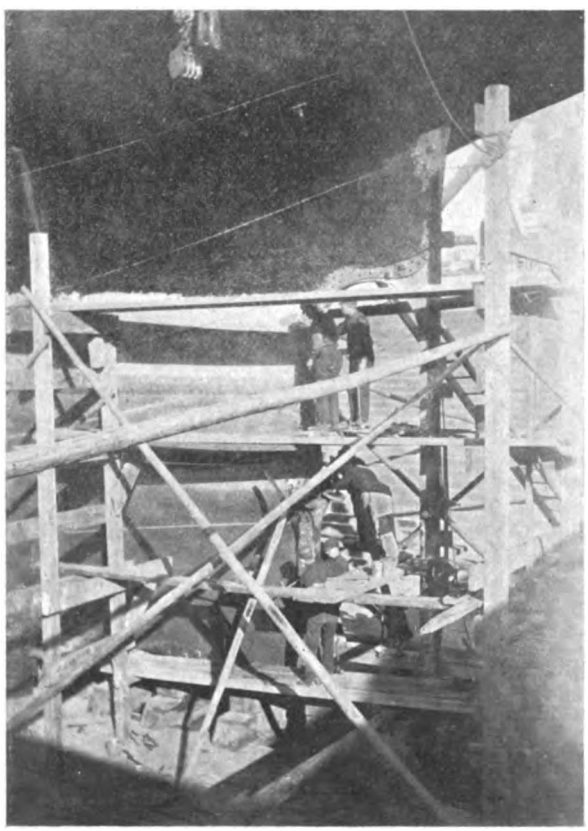
MISHAPS AND REPAIRS.

Stern Frame and Rudder Forged and Fitted.

The S. S. Horrox, grounded on the bar at Charleston, S. C., and when she was pulled off was towed to the Erie Basin Dry Dock, Brooklyn, N. Y. There an examination was made, in dry dock, in the latter end of March. The stern frame was broken, the shoe being missing, and the rudder stock was fractured. Both stern frame and rudder would have to be replaced. Repairs were ordered, and the rudder was

DRILLING RUDDER FRAME IN DOCK YARD.

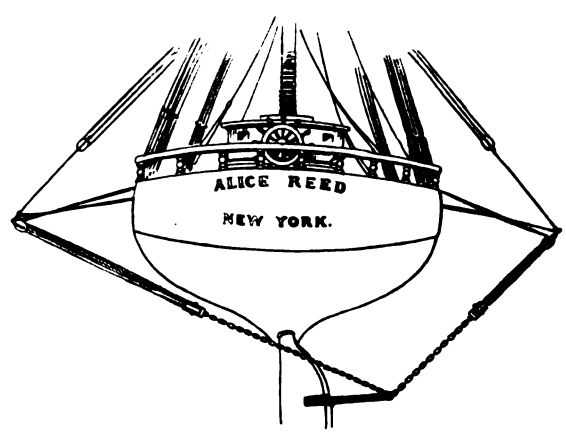


RIVETING STERN FRAME IN DRY DOCK.

unshipped, the rivets in the stern frame cut out, the propeller taken off, and the shaft and stern tube hauled in. The portion of the stern frame remaining was drawn out and landed on the dock. Plates were then bolted over the opening in the after bulkhead, through which the stern tube passed, and made watertight. Then the dock was filled, and the vessel hauled out to await the arrival of the stern frame and rudder. Drawings of these were prepared and sent to the forge, and templates were also made of the stern frame. One of these was sent to the forge, and the other kept in the yard and marked and drilled for the rivet holes. The forgings were delivered at the yard in three weeks. The stern frame was laid on blocks near the dock and the rivet holes marked from the template in the usual way. Drilling was then commenced with the portable machines, which are shown in the illustration, while drilling the rudder frame. Four to six of these machines, each driven by an independent vertical engine through suitable gear, and shafts fitted with universal couplings, were worked at the same time, using twist drills. While the rivet holes were being drilled, 2 in. holes were also drilled in the gudgeons. When the frame was ready the vessel was again docked, and the frame put in position. While the riveting gangs were at work the holes in the hub were drilled, and a boring machine, worked by a small vertical engine, put in the dock, was was started on the gudgeons to enlarge the holes for the rudder pintles. The hub of the stern frame was also bored out to the center line of the shafting, and also to suit the stern tube. When all this work was completed the stern tube was put in position, the shafting hauled out, and the propeller put on. The rudder meanwhile had been finished in the yard, and when the pintles were put in place, the rudder was shipped, the quadrant and tiller fitted, and the steering gear connected. Then the vessel was ready for sea. The stern frame weighed 12,240 pounds; the rudder frame, 6,422 pounds, and with the plates, 8,980 pounds. The forgings were made by McPherson, Willard & Co., Bordentown, N. J., and the work of repairs was carried out by the John N. Robins Co., ship and engine builders.

Steered 6,000 Miles with Jury Gear.

A simple and very effective method of overcoming a very serious difficulty, is shown very clearly in the drawing of the stern of the bark Alice Reed.



JURY GEAR IN POSITION.

This vessel entered the port of New York recently after having been kept on her course for a distance of about 6,000 miles with the jury steering gear shown. While on a voyage from Montevideo to this port the bark was struck by a squall and the rudder head was twisted off. Steering was, of course, impossible with the ordinary gear, and Capt. Ford decided to rig a jury gear. Spars were run out from

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the sides near the stern and lashed securely. To the outboard ends block and tackle was secured and connected to the chains of the monkey tiller. Inboard the ends of the tackle were guided by snatch blocks to the wheel house, where they were made fast to the drum of the wheel. The work was finished in a few hours, and when headway was got again the ship was more manageable than would be expected. With this gear the voyage was continued without further interruptions, although very severe gales were encountered in the North Atlantic. The cargo of wool and hides was delivered in sound condition to the consignees here.

CONSTRUCTION NOTES.

The New York Yacht, Launch and Engine Co., Morris Heights, New York City, is building a large cabin launch for W. W. Kenyon, of Brooklyn, N. Y. Her dimensions are 31 ft. over all, 7 ft. beam, and 30 in. draught. The cabin is to be finished in mahogany, with plush cushions on the seats, and lockers under same, and extensions to form berths. In the after end of the cabin is the galley, on the starboard side, and the toilet on the port side. The engine space and crews' quarters come after this. She is built in the most substantial manner, with oak timbers, cedar planking, and is copper fastened. The motive power will be an 8 horse-power Otto gas engine. She is expected to be a very speedy as well as safe boat. She will be ready to launch in about three weeks. The company is also building a 50 ft. oyster boat, with 12 ft. beam, fitted with two 12 horse-power Wing marine gas engines. This boat while 15 ft. beam on deck is only 12 ft. beam at water line, being flared out in order to take a very heavy load. They are also building several handsome launches to be fitted with the Wing marine gas engine.

The Neafie and Levy Ship and Engine Building Co., Philadelphia, Pa., has now under construction for the Winthrop Steamboat Co., Portland, Me., a steel single screw passenger steamer 150 ft. long, over all, 30 ft. beam, and 11 ft. deep. She will be fitted with one inverted, direct-acting surface condensing triple-expansion engine 15 in., 23 in. and 39 in. cylinders by 28 in. stroke of piston, and one boiler 13 ft. 6 in. dia. by 12 ft. long. She will be handsomely fitted up with accommodations for about 900 passengers. The steamer is expected to be completed in about six weeks, and will run on the Plymouth route. The company is also building for the Baltimore and Philadelphia Steamboat Co., one steel single screw passenger and freight steamer intended for service between Philadelphia and Baltimore.

Jackson and Sharpe Co., Wilmington, Del., has made a contract with the Philadelphia Floating Elevator Association for the construction of a grain barge to be used in that port. She will measure 153 ft. between perpendiculars, and 160 ft. over all; 25 ft. 9 in. in breadth and 11 ft. in depth. When loaded she will carry about 26,000 bushels of grain. She will have one deck, with a hatch 14 ft. wide, 120 ft. long, and 30 in. high, and will have a small cabin for workmen, and pilot house. Her hull will be of white oak and yellow pine. The company is also building a tug for the Chesapeake & Ohio Railroad Company. This is a wooden vessel, 100 ft. long, over all, 23 ft. beam and 10 ft. 3 in. deep. She will be fitted with two bulkheads and with propelling machinery consisting of a compound engine, 36 in. and 20 in. by 26 in., and one Scotch boiler 11½ ft. in dia. and 11½ ft. long, to work at 125 pounds. For Hughes Bros. & Bangs, who have the contract for the construction of the Harbor of Refuge in Delaware bay, the company is building two dumping scows 180 ft. long, 40 ft. beam and 12 ft. deep, fitted with pockets and dumping gear, to carry about 1,200 tons. Also a deck scow 180 ft. long, 40 ft. beam and 12 ft. deep, with knee bilge, built in the usual car float style, and to carry about 1,500 tons on deck.

The Gas Engine and Power Co., and Charles L. Seabury and Co., Consolidated, Morris Heights, New York City, have a large amount of yacht work on hand. The Hiawatha, just launched, is 170 ft. over all. She has a steel hull and remarkably handsome lines. She has a triple expansion engine and two Seabury boilers, designed to furnish steam to the 1,000 horse power engines at a pressure of 250 pounds. Two sister steam yachts have also just been launched. One of them, the Punjaub, is for F. L. W. Masury, the other, named the Raynham, is for E. S. Woodward. These boats are 85 ft. over all, with flush deck, single screw and engines of about 175 horse power. They were launched all completed. Among the yachts undergoing repairs are the Wachusett, F. T. Holder, having her stern lengthened and a clipper bow and spars put in; the Wabeno, Frederick Gerken, lengthening her stern and undergoing general alterations; including a new Seabury boiler; the Kanawha, John P. Duncan, lengthening her stern and general alterations; the Althea, T. E. Ward, to be equipped with an electric light plant and general repairs and overhauling; the Orienta, J. H. Ladew, a new shaft and refinishing the saloon and deck; the Alcina, O. A. Dorman, cabin reconstructed and finished in mahogany. The old Hiawatha has been purchased by J. Herbert Ballantine, Newark, and will receive extensive alterations. The Maspeth, Chris. Meyer, is having a clipper bow and her stern lengthened, her steam plant overhauled and renewed. Two steam tenders are also being constructed, also eight or ten naphtha tenders; a naphtha boat for the Health Department of New York City; two for the Police Department; one for the Health Department of Charleston, N. C., and about fifty launches for individuals, varying in length from 18 ft. upward.

The Columbia Engineering Works, McNeil Bros., Proprietors, William and Imlay streets, South Brooklyn, are at the present time making extensive alterations and repairs to the Brooklyn fireboat, Seth Low. The engines are having a thorough overhauling, also the fire pumps, which are having new brass water-backs and new linings. Her boiler has been raised, reset, retubed and thoroughly overhauled. They are also converting the boat so as to run high or low pressure; in doing this they are fitting a new Wheeler admiralty condenser, and new Blake air pump. This necessitates all new copper piping and new valves and hot wells, the former piping having been badly damaged when the boat was in collision some time ago. They are also fitting new tail end shafts on this vessel, and expect to have her ready for service about May 1. The works are also executing repairs on the new steamship, Verona, of Glasgow, which arrived from Sunderland in ballast three weeks ago. They have a force of 200 men at work on this vessel, cutting out and renewing the strained rivets in decks, hull frames, butts and hatches. This vessel encountered fierce gales on her way across the Atlantic. Her engines and shaftings, etc., have been thoroughly examined and repaired, and vessel will soon be ready for sea. They have also just completed extensive repairs to the British steamer Silvia, having overhauled her pumps and boilers and fitted new thrust rings. Other steamers undergoing repairs are the S. S. Rosemarron, docked, and propeller renewed; S. S. Vittoria, of Glasgow, general engine repairs; S. S. Mowen, of Glasgow, fitting out for China, general engine repairs and dry-docking to remove propeller and shaft; also work on the S. S. Edwin, of North Shields; S. S. Brittanic, French; S. S. American, British.

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EDUCATIONAL.

THE INDICATOR APPLIED TO THE MARINE ENGINE.—2.

BY HENRY L. EBSEN.

The necessity for the even distribution of power in a marine engine, referred to in the preceding article, can be more readily understood by reference to Fig. 1. This is a theoretical combined diagram of a triple expansion engine. AD represents the volume of steam admitted to the H. P. cylinder, BE the volume admitted to the I. P. cylinder, and CF the volume admitted to the L. P. cylinder. The quantity of steam AD, at the pressure KA, expands in the H. P. cylinder, to the volume BE and pressure KB, and is received by the

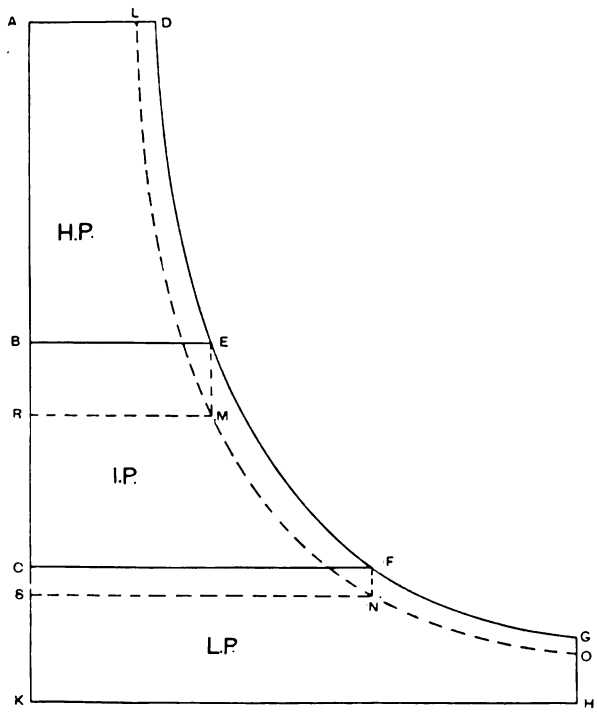

FIG. I.

I. P. cylinder at the pressure KB and volume BE, and by the L. P. cylinder at pressure KC and volume CF, so that the line BE represents the volume of the exhaust of the H. P. cylinder and admission to the I. P. cylinder, and CF represents the volume of the exhaust of the I. P. cylinder and the admission to the L. P. cylinder. In the L. P. cylinder the steam at the end of the stroke is at a pressure of HG, and exhausts to the condenser. In the case of the full lines the powers developed by the cylinders are equal, and the areas of the different cards ADEB, BEFC and CFGHK are equal to each other. Now, if the H. P. cylinder be linked up, the volume of steam entering it will be equal to AL. If the I. P. cylinder is not linked up correspondingly, the volume of the steam to the point of cut off will still be equal to BE, and as a smaller quantity of steam is now passing through the cylinders, it will drop to a lower pressure when it occupies this space. If a perpendicular is let fall from E, intersecting the new expansion curve at M, RM, which equals BE, will be the new back pressure line of the H. P. cylinder, and admission to the I. P. cylinder. In the same way, SM will be the new back pressure line of the I. P. cylinder, and admission to the L. P. cylinder. It will now be seen that the new area of the H. P. card ALMR has not been diminished much from the original area, while the I. P. card has been reduced, and the L. P. card also suffers a reduction in area.

The next important function of the indicator is that of locating faulty valve adjustments. It is hardly to be expected after the care that is bestowed upon the design of a valve gear of large marine engines, and the constant care it receives, that their indicator diagrams would ever be so misshapen as those which are occasionally taken from neglected stationary engines. In fact, if any mistakes of this kind did exist, the engine would soon make life unbearable to those who had to live near it and care for it. Nevertheless, the valve adjustment requires much study, and slight changes are made continually, and the effects carefully noted, with the object of bringing the engine to a higher degree of efficiency. As the prevailing style of marine engine is the vertical inverted type, the wear of the valve gear must be closely watched. If the top eccentric strapliner and the saddle block slipper show any wear, thereby lowering the valve, the indicator diagram will show this by the increased length of steam admission on one side and decreased length on the other side, in addition to displacing the points of release and compression. A little experience will enable the engineer to judge what thickness of liner must be inserted under the foot of the eccentric rod to bring the valve to its original position, without having to open up the valve chest to get the setting. In case the power is not evenly distributed between the cylinders, and linking in or out on one cylinder should disturb the point of compression or release to such an extent that the engine would pound, a slight increase or decrease of the steam lap of the valve will often give the desired result, although this would alter the lead. The diagram now taken will plainly show the difference in cut-off, while the lead will remain practically unaltered. This will demonstrate the fact that the indicator diagram is a more reliable means of judging the action of steam in the cylinder than it is of what the dimensions of the valve setting would be. The above case is only applicable to small alterations, as large alterations would necessitate the shifting of the eccentric sheave.

The point of release is another important consideration. It is advisable to have it as early in the stroke as the setting will allow, so that the exhaust steam will reach the following cylinder before cut off has taken place in the latter, otherwise that cylinder will drain the receiver of steam exhausted from the previous stroke of the first cylinder, causing considerable drop in pressure in its admission line, and at the termination of the next stroke the first cylinder exhausts into the receiver again at a gradually rising pressure. If the first cylinder were now to exhaust to the second before its point of cut off, its exhaust line as well as the admission line of the second would be of more uniform pressure. Therefore a small alteration of the release points will alter the shape of the diagrams, and likewise effect the distribution of power. Alterations of this kind are made by diminishing the exhaust lap of the valve, and as this also reduces the compression, which is undesirable, it is usually necessary to alter the angle of advance on the eccentric sheave. The above difficulty is experienced in engines that have not sufficient cylinder capacity so that the point of cut off occurs at more than three-quarters of the stroke in each cylinder.

The point when the valve closes for compression can be easily located on the diagrams of all the cylinders excepting that of the low pressure cylinder. When the piston in this cylinder begins to compress the exhaust at 25 in. of vacuum, the pressure does not immediately begin to rise, as the vapor, or fog as it may be called, requires an amount of compres-

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sion to bring it to the gaseous state before its pressure will rise. Therefore this cylinder usually does not get enough compression, and as any shifting of the point of compression would disarrange the other points on the diagram, the valves in the more improved engines are usually equipped with Thom's patent passover port; see Fig. 2. Previous to the point of release at one end of the cylinder this port transfers a small amount of steam to the opposite end just as the valve is closing for compression, thus giving the piston something substantial to compress. The diagrams taken from a cylinder fitted with such a valve show a sudden rise in pressure at the compression point, previous to actual compression, and are often a puzzle to the uninitiated. Figures 3 and 4 are diagrams taken before and after the adoption of a valve with a passover port, and the amount of compression in the latter case was sufficient to make the engine run perfectly quiet.

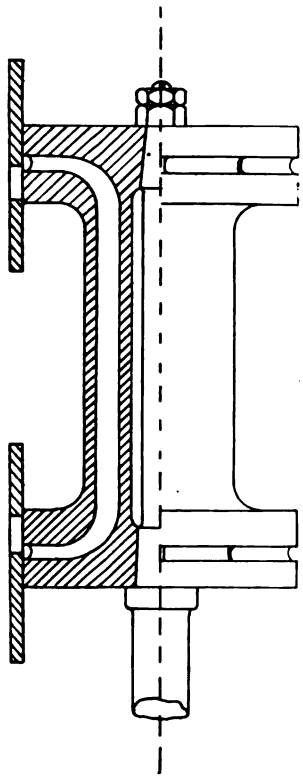

FIG. 2.

Marine engines nowadays are very frequently fitted out with piston valves, the larger cylinders having two of them side by side, the rods of which are both driven from a single crosshead. The weight of this gear is quite considerable, and to avoid having abnormally large eccentric sheaves, straps and rods, each valve has a balancing device. In former years these balance gears were simply cylinders on the valve bonnets, the pistons of which were attached to the valve stems, with steam or atmospheric pressure on the bottom side, and connection to the condenser on the top side. These devices, no doubt,

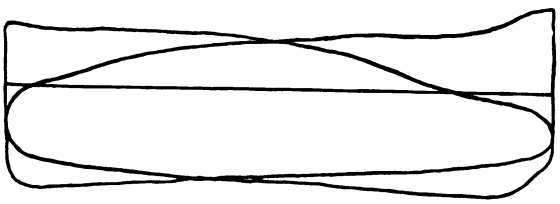

FIG. 3.

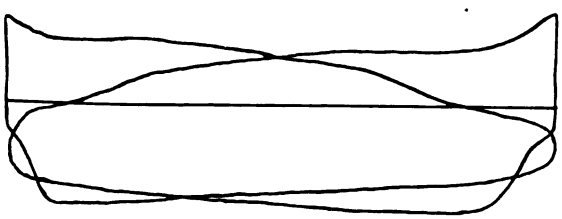

FIG. 4.

balance the valve gear to some extent, but at high speed the momentum of the gear must be taken into account, as the strains caused by this will sometimes greatly exceed those caused by the weight of the gear. There are different styles of patent momentum balancing cylinders in use, in which the piston lifts the valve gear at the beginning of the up stroke, checks its momentum at the top, assists it to start on the down stroke, and checks its momentum and

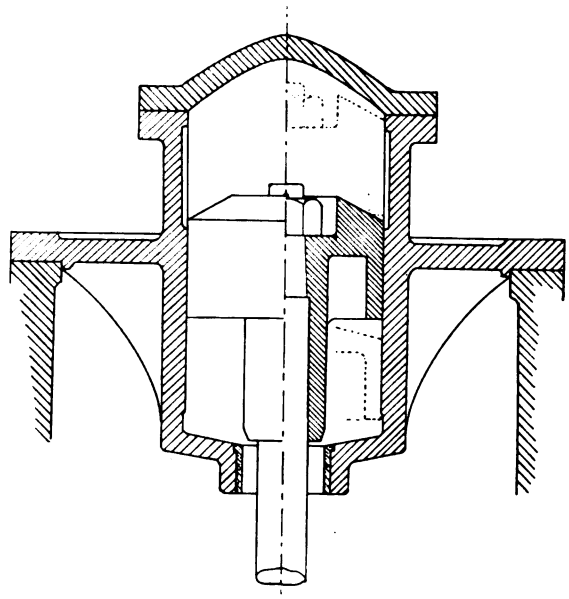

FIG. 5.

weight when approaching the bottom. These balance cylinders have indicator connections, and although the diagrams taken from them do not vary much, they are useful to determine any piston leakage that

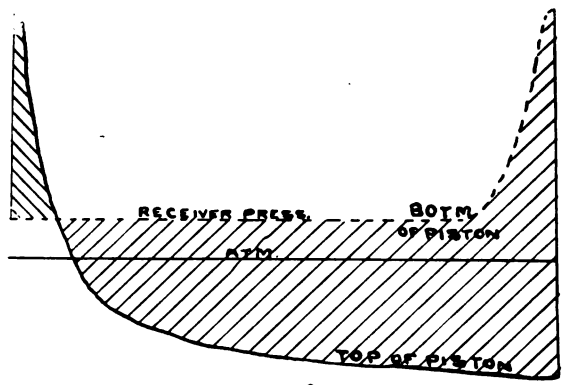

FIG. 6.

would impair their efficiency. Fig. 5 shows Thom's patent momentum balancing cylinder, which is one of the most efficient, and Fig. 6 is a diagram taken from it. The large shaded portion shows the upward pressure of the piston, and the small shaded portion shows the downward pressure.

The U. S. Gunboat Annapolis, 1,000 tons, built by Lewis Nixon, at the shipyard in Elizabethport, N. J., went on her official trial trip April 22. Everything considered, some remarkable results were achieved, the vessel exceeding the contract requirements in all particulars. The mean speed for the run of 48 knots in Long Island Sound was 13.43 knots. The maximum rate during the trial was 14.18, which figures were promptly painted on the funnel by the crew. The Annapolis is the first of the gunboats fitted with spars and canvass to be completed.

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HOME AND FOREIGN EXCHANGES.

Lord Brassey on the British Seaman.

Writing to the London Times from the Antipodes, Lord Brassey discusses the British seaman and the Royal Naval Reserve:

Residents in Melbourne, one of the few busy ports in which large fleets of sailing ships may still be seen, affords exceptional opportunities of judging of the quality of the British seaman of the modern time. I ask leave to give in your columns impressions formed from close personal observation and consultation with experienced ship masters.

Throughout the recent discussions on the manning of our Merchant Navy no doubts have been expressed as to the officers. The confidence of the Admiralty has been conspicuously shown on a late occasion, when commissions were given to a hundred lieutenants selected from the Mercantile Marine.

It cannot be claimed that the same uniform excellence is found before the mast. British seamen of the finest type may still be seen, and more education and as good seamanship as those who have gone before. Their numbers, however, are growing less, while the foreign element is increasing.

The causes of the reduction of numbers are not far to seek:

(1) Sailing tonnage is being more and more displaced by steam. The advantage in certain trades is open to question. The power supplied by the wind is cheap, and, in the average of long voyages, it is less uncertain than might be supposed. Its use should not be discarded for the transport of bulky commodities for which early delivery is not of urgent importance. Steamers may show good profits on their early voyages, but they depreciate rapidly. These considerations should prevent the entire disappearance of sailing ships. Such, however, is the tendency of the hour, and we are gradually losing the best school for the training of young seamen.

(2) The seaman has not fully shared in the social and material progress of those who follow easier callings. For the hardships and privations which are his inevitable lot he has received no compensation in wages, his earnings being below those obtainable in any description of skilled labor on shore. The latest returns issued by the Board of Trade give the monthly pay of seamen in the Australian voyage at 55s. (fifty-five shillings), and there is no prospect of higher remuneration. Excessive competition has brought down freights to the wholly inadequate rate of from 20s. to 30s. a ton from Melbourne to London.

A general review of all the circumstances points clearly to the conclusion that it is only by direct aid from the State that our Mercantile Marine can be preserved as a nursery for blue-water seamen. An ample supply of men from the fisheries may be obtained without assistance from the Government. But a certain proportion of men of a wider experience should be found in the reserve of the Navy.

We have an admirable example of a well-organized reserve in the French Inscription Maritime. Established under Colbert, it has been sedulously perfected by successive administrations, and the results well merit attention. With a Merchant Navy of under 900,000 tons, as contrasted with the 10,500,000 tons of the British Empire, the French have no less than 135,000 men on the rolls. Omitting all non-effectives, a solid contingent of 40,000 men could certainly be furnished to the fleet in time of war. Of the French reserve 71,000 men are drawn from the coast fisheries, 10,000 from the deep-sea fisheries, 18,000 from the coasting trade, 21,000 from foreign-going ships. The remainder are serving in pilot boats and yachts. By skilful organization the French have at their disposal more men than they could employ afloat, while our ability to man our ships is being called in question. We may accept the assurance that the resources for manning are adequate. But the further expansion of the fleet will call for increased numbers of seamen, and considerations of economy must impose some limit on the permanent force. All compulsory service creates burdens which are not shown in Navy and Army Estimates; but when every allowance has been made the direct cost of the French Inscription Maritime is relatively small. The exclusion of foreigners from vessels under the French flag puts no charge on estimates, while giving to the native seamen a valuable monopoly. In addition to this and other privileges the fisheries and Mercantile Marine of France are supported by bounties on a liberal scale. The seaman who has served 300 months afloat receives a pension in old age.

In a work on British seamen published many years ago, at the close of the inquiry of the Unseaworthy Ships Commission, I urged that the training of seamen should be encouraged by a bonus to shipowners as well as by retainers to apprentices and seamen. I venture to renew the suggestion, believing it to be the only means of making our Merchant Navy as capable as that of France of rearing seamen for the fleet. Terms and conditions should be so laid down by the Admiralty as to secure satisfactory results. Only sailing ships should be subsidized. They should be of a suitable type and employed in voyages of circumnavigation. The numbers of their crews and their qualifications should be defined. All seamen and apprentices of the reserve should be bound to serve when called upon. They should appear at stated intervals for inspection.

The Naval Reserve should be more thoroughly trained than at present. Every man in the French reserves serves for forty months in the navy. Our Reservists should do two years' service, possibly in ships specially commissioned.

Canadian Trans-Atlantic Service.

After years of agitation Canada is about to have a fast line of steamers that will prove formidable competitors of the best that now make New York their terminus, says the Marine Record. It is announced on what appears to be official authority that the Canadian Government has awarded a contract for a period of 10 years to the English firm of Peterson, Tait & Co., of Newcastle, to place on the route between Montreal and Liverpool four steamships of 10,000 tons each and a speed slightly exceeding 21 knots. Two of the new boats are to be ready for the beginning of the season of 1899 and the other in 1900. They are to have 50 per cent more accommodation for passengers than the greyhounds of the Cunard Line, the Lucania and Campania, and 50 per cent more promenade accommodation, while they will be also superior to them in their appointments and equipment. They will be further supplied with cold storage accommodation to the extent of 500 tons, which, however, if needed, is to be subject to increase to 1,000 tons at the demand of the government.

The boats will run from Montreal, or possibly Quebec, to Liverpool in the summer, and from Halifax in the winter. W. Peterson, of the English firm mentioned, has been in Canada for two weeks, in consultation with the Dominion Government on the matter. It is said the annual subsidy to be paid by the Dominion is $500,000, to which the imperial government will add $250,000. It is stated that the Dominion Government, in addition to entering into an arrangement for a fast Atlantic steamship service, intends deepening the St. Lawrence canals to a uniform depth of 14 ft., the work to be completed within two years.

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A British View of American Methods.

At this time, when a large amount of anxiety is felt about the future of English trade, says The Engineer, London, and when all causes that may account in any degree for the depression of it as a whole or in part, and when all possible means which may conduce to its recovery, are freely discussed, it will not be without interest to call attention to a point which has been practically unnoticed so far, and one which we think may not be without important bearings from certain points of view on our commercial interest. We refer to trade secrets. If the characteristics of a country may be legitimately gathered from the press of that country, we may say without hesitation that no country in the world holding important manufacturing interests is so reticent about its methods of work as England. If we turn to American or continental books or papers, we find that the manufacturers of those countries do not only willingly give information about their work, but, if anything, seem to encourage the circulation of such information. For the moment it matters not at all what their ulterior motives in doing so may be. It may be that it is looked upon as a good and cheap advertisement, or the information may be imparted from the sheer love of telling something known, a characteristic largely developed in many persons; or it may be from a self-satisfied feeling of knowing a great deal more about some particular method or system than any one else, and wishing to let the rest of the world appreciate that superiority. The motive does not matter; the fact of its being done is of great importance. Of no country is this observation truer than of the United States.

The Americans seem to be more generally willing to exchange information than other people. For a proof of this it is only necessary to turn to the discussions of their learned societies. Without wishing to disparage our own societies, we are forced to admit that we very rarely have anything that approaches the thoroughness of the investigation which follows the reading of a paper before an American institution. Member after member rises, and each is not content with some mere platitude or weak and unsuggestive question, but gives honestly and fully all he knows about the matter under discussion, and hunts in the recesses of his memory for the last little point of importance. The consequence is that not only are the "Proceedings" of the societies invaluable treatises on varied subjects, but that each member performs the office of a whetstone for his neighbor, urges him to initiate investigations on his own account, and introduces him to new fields of thought. It is only necessary to look to America to see the result. Whatever faults we may have to find with a tendency to exaggerate, from which our cousins are not entirely free, it must be acknowledged that, due discount being allowed for that failing, American engineers and scientists are making rapid strides, and as the foundations of thought gain in firmness from the reasons which we have attempted to indicate above, these strides are made, not with more confidence—that were impossible—but with fewer resulting disasters. In all branches—let us refer particularly to engineering—American work is annually becoming more trustworthy, and the thoroughness with which it is gone into is in marked contrast to a backward tendency in this country.

In France, too, although perhaps more superficially, both books and papers show that manufacturers and scientists are very fairly free with their knowledge. In Germany the technical colleges, being in many cases actually fostered by the makers, do a great deal towards the distribution of information.

It must surely be unquestionable that this readiness to give and take assists the advancement of a people. A selfish desire to make a secret of one's methods is not only harmful to the original person, but hinders as it is of course intended to do the advancement of others. It may seem hard to blame a man for keeping to himself the secret of a success which he has only gained by strenuous work, and the retention of which gives him a monopoly in the matter to which it refers; but there can be little question that if he made his fellows acquainted with all he had attained, and how he attaned it, he would do a great amount of good, and further the interest and welfare of his land. It must be very questionable, too, if he would not in the long run do himself also a service; for not infrequently the person who believes himself in the possession of a master secret is blind to the advance around him, and only becomes aware of it when he finds that his secret is no longer of value, because some better than it has been discovered. Concealment of knowledge is, as a rule, suicidal, not necessarily to the one person, but to the art or craft to which it refers. If our manufacturers went to scientific meetings, not with the intention of carrying away what few crumbs some rival might let fall, but of sharing their loaves round, it is far more than probable that the lack of technical knowledge which exists now-a-days would be unknown, and that a more healthy rivalry at home would have strengthened us against the dangerous rivalry abroad.

Protection for Large Cruisers.

The armored deck of each of the new great cruisers, Powerful and Terrible, which is made up of several steel plates, one over the other, either an inch or an inch and a half in thickness, serves both for the purpose of horizontal and vertical armor, as it rises at the middle line to 3 ft. 6 in. above the surface of the water, and dips at the ships' sides 7 ft. below it, thus giving a camber of 10 ft. 6 in. covered with armor, which would prevent the entrance of projectiles to the vitals of the ship. This armored deck extends from stem to stern. Over the machinery spaces it is two and one-half inches thick upon the flat or crown of the arch. At the curved sides it is 4 in. thick. Forward and aft of these spaces it is 2.5 in. thick from the point where it enters the stem to the projecting portion over the stern post; there are patches at the sides 3 in. thick. No portion of the deck armor is 6 in. thick, as sometimes stated; the idea has possibly arisen from the fact that the sloping nature of the 4 in. deck armor over the curve at the ships' side makes the horizontal distance through it 6 in., or, indeed, a little more. The entire weight of the armored deck is almost 1,300 tons, independently altogether of the vertical shield for the gun casements, etc.—The Navy and Army Illustrated, London.

The April issue of the Rudder contains a very instructive illustrated article by Naval Architect A. Cary Smith entitled "Application of Experience in Yacht Designing as Applied to Commercial Vessels."

The Directors of the Cunard Company have submitted a statement of accounts to stock-holders, for 1896, which shows considerable improvement in the past twelve months and good prospects for the future. The profits for the year, including $3,327 brought forward from 1895, were $1,248,940. Of this a reserve of $824,110 was set aside for depreciaion of ship and wharf property, and $162,085 to the insurance fund. This left a total of $160,905 Out of this the Directors recommended the payment of a dividend of 2.5 per cent amounting to $200,000 which left a balance of $10,905 to the credit of the profit and loss account for the present year. The company has ordered three new steamers for the Mediterranean trade.

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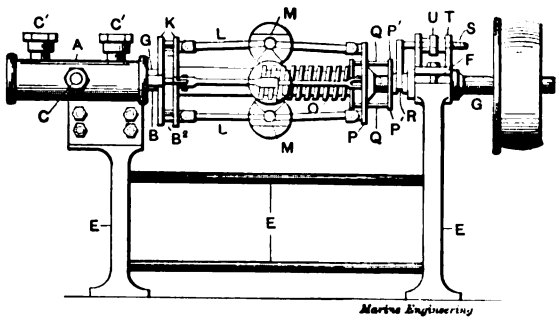
SELECTED PATENTS.

579,204—GOVERNOR FOR MARINE ENGINES. *Alexander Wilson, Hull, England. Filed Feb. 10, 1896. Patented in England.*

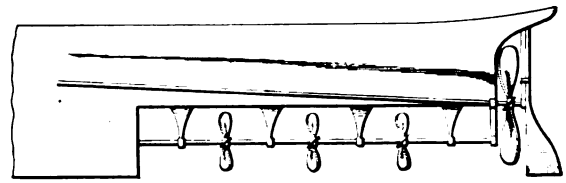
An apparatus for governing marine engines to prevent them racing, consisting of a large cylinder A^1 and a small cylinder A with piston-valves B and D



and inlet and outlet pipes C and C^1 respectively operated by means of arms L and falls M, shaft G having disks J and K, the piston-valve of the small cylinder A being operated by the fork B^2 working in the groove K^1 of the loose disk K, the whole being driven by means of the pulley H connected by a strap or rope to a pulley on the driving shaft of the engine as shown. 2. In apparatus for preventing marine engines racing the employment of a fork R having a screwed end S adjusted by means of a nut U and bearing against connected disks P and P^1 or compressing the spring O, so regulating the movements of the balls M and the shaft G driven by the pulley H connected to the driving shaft of the engine. 3. The apparatus for governing marine engines and to prevent them racing, consisting of cylinders A^1 and A having pistons B and D, springs B^1, pipes C and C^1; the pistons being operated by the fork B^2, disks K and J, rods L, balls M, shaft G, driving-pulley H, spring O, fork R, adjusting nut U, disks P and P^1, all operating in the manner and for the purposes described.

578,987—MECHANISM FOR PROPELLING VESSELS. *Jaspar Hays, Nashville, Tenn. Filed March 24, 1896.*

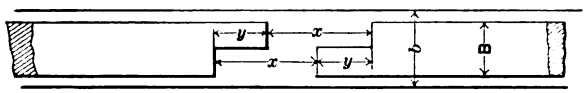
The combination with the hull having a compartment under the stern, a horizontal shaft arranged parallel with the upper wall of the hull and carrying propellers, a shaft arranged above the horizontal

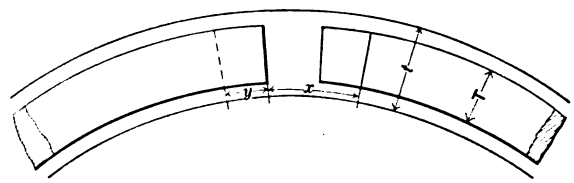


shaft, and at an incline, and a single propeller on the outer end of the inclined shaft, the propeller being of larger size than the others and forming the outer propeller of the series.

DIMENSIONS FOR PISTON PACKING RINGS.

The following formulæ and table of dimensions for piston packing rings will be found useful for reference:





D	d	T	t	B	b	x	y	D	d	T	t	B	b	x	y	D	d	T	t	B	b	x	y
10	10¾	3/8	5/8	1 5/8	1 1/16	1 3/8	1 1/16	30	31 11/16	1	1 1/16	2 3/4	2 1/16	3 7/8	1 1/16	50	52 5/8	1 1/16	2 1/8	3 9/16	3 1/16	6 1/2	2 3/4
11	11 3/4	7/16	11/16	1 11/16	1 3/4	1 7/16	1 1/4	31	32 3/4	1	1 7/16	2 1/2	3	4	2	51	53 1/16	1 5/8	2 3/16	3 9/16	3 1/8	6 5/8	2 3/4
12	12 1/8	7/16	3/4	1 3/4	1 7/8	1 7/16	1 1/4	32	33 1/16	1	1 7/16	2 1/2	3	4 1/16	2	52	54 1/4	1 5/8	2 3/16	3 5/8	3 1/8	6 3/4	2 1/8
13	13 1/8	1/2	13/16	1 13/16	1 15/16	1 5/8	1 5/16	33	34 1/8	1 1/16	1 1/2	2 5/8	3 1/16	4 5/16	2 1/16	53	55 1/16	1 1/16	2 1/4	3 5/8	3 1/8	6 1/8	2 1/8
14	14 1/8	1/2	13/16	1 7/8	2	1 7/8	1 5/16	34	35 1/8	1 1/16	1 1/2	2 1/2	3 1/8	4 5/16	2 1/16	54	56 1/8	1 1/16	2 1/4	3 1/4	3 1/16	7 1/16	2 1/8
15	15 1/16	9/16	7/8	1 15/16	2 1/16	1 15/16	1 3/8	35	36 1/16	1 1/16	1 5/16	2 1/2	3 1/8	4 5/16	2 1/8	55	57 1/8	1 1/16	2 1/16	3 1/4	3 1/16	7 1/16	2 1/16
16	17	9/16	7/8	2	2 1/8	2 1/16	1 3/8	36	38	1 1/8	1 1/16	3	3 3/16	4 1/16	2 1/8	56	58 1/16	1 3/4	2 3/8	3 3/4	4	7 1/16	3
17	18 1/16	5/8	1 1/16	2 1/16	2 3/16	2 1/16	1 7/16	37	39	1 1/8	1 1/16	3 1/16	3 1/4	4 1/16	2 3/16	57	60	1 3/4	2 3/8	3 3/4	4	7 1/16	3
18	19 1/16	5/8	1 1/16	2 1/8	2 1/4	2 1/16	1 7/16	38	40 1/16	1 1/16	1 1/16	3 1/16	3 1/4	4 1/16	2 3/16	58	61	1 1/16	2 7/16	3 1/16	4 1/16	7 1/16	3 1/16
19	20 1/16	1/16	1	2 3/16	2 5/16	2 7/16	1 1/2	39	41 1/8	1 1/16	1 1/16	3 1/8	3 5/16	5 1/16	2 1/4	59	62 1/16	1 1/16	2 7/16	3 1/16	4 1/16	7 1/16	3 1/16
20	21 1/16	1/16	1 1/16	2 1/4	2 3/8	2 5/16	1 1/2	40	42 1/16	1 1/4	1 3/4	3 1/16	3 5/16	5 5/16	2 1/4	60	63 1/16	1 7/8	2 1/2	3 7/8	4 1/8	7 1/16	3 1/8
21	22 1/4	3/4	1 1/8	2 5/16	2 7/16	2 1/4	1 5/16	41	43 1/4	1 1/4	1 3/4	3 1/16	3 5/16	5 1/4	2 5/16	61	64 1/16	1 7/8	2 1/2	3 7/8	4 1/8	7 1/16	3 1/16
22	23 5/16	3/4	1 1/16	2 3/8	2 1/16	2 7/8	1 5/16	42	44 1/4	1 5/16	1 13/16	3 1/4	3 7/16	5 1/2	2 3/8	62	65 1/16	1 13/16	2 9/16	3 15/16	4 3/16	8 1/8	3 3/16
23	24 3/8	1/16	1 1/16	2 7/16	2 9/16	3	1 5/8	43	45 5/16	1 3/8	1 13/16	3 1/4	3 7/16	5 5/8	2 7/16	63	66 1/4	1 13/16	2 9/16	3 15/16	4 3/16	8 1/4	3 1/4
24	25 3/8	1/16	1 1/4	2 1/2	2 5/8	3 1/16	1 1/16	44	46 3/8	1 3/8	1 7/8	3 5/16	3 1/2	5 3/4	2 1/2	64	67 3/16	2	2 5/8	4	4 1/4	8 3/8	3 1/4
25	26 7/16	1/16	1 1/4	2 1/2	2 11/16	3 1/4	1 3/4	45	47 7/16	1 7/16	1 13/16	3 3/4	3 15/16	5 7/8	2 1/2	65	68 3/8	2	2 5/8	4	4 1/4	8 1/16	3 5/16
26	27 1/2	1/8	1 1/16	2 5/16	2 3/4	3 3/8	1 3/4	46	48 1/2	1 7/16	2	3 3/8	3 5/8	6	2 5/16	66	69 1/16	2 1/16	2 11/16	4 1/16	4 5/16	8 5/8	3 5/16
27	28 5/16	1/8	1 1/16	2 5/8	2 13/16	3 1/2	1 13/16	47	49 1/2	1 1/2	2 1/16	3 7/16	3 11/16	6 1/16	2 5/8	67	70 1/16	2 1/16	2 11/16	4 1/16	4 5/16	8 3/4	3 3/8
28	29 5/8	1/16	1 3/8	2 11/16	2 7/8	3 5/8	1 7/8	48	50 5/16	1 1/2	2 1/16	3 7/16	3 11/16	6 1/4	2 5/8	68	71 1/2	2 1/8	2 3/4	4 1/8	4 3/8	8 7/8	3 7/16
29	30 5/8	1/16	1 3/8	2 3/4	2 11/16	3 3/4	1 11/16	49	51 5/8	1 9/16	2 1/8	3 1/2	3 3/4	6 3/8	2 11/16	69								

D=Cylinder diameter.
d=Outside diameter of ring after rough turning.
$d = 1.047D + .24$
$T = .07 + .03D$
$t = .07 + .03D + .07\sqrt{D}$
$B = .5\sqrt{D}$
$b = .54\sqrt{D}$
$x = .131D$
$y = .04D + .75$

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ADMIRALTY LAW.

U. S. CIRCUIT COURT OF APPEALS.

In a Collision, Both Parties Negligent.

The responsibilities of navigation in a narrow harbor channel, are considered in the case of the collision between the fruit steamer Bowden and the Decatur H. Miller, of the Merchants' and Miners' Transportation line.

The Miller had discharged most of her cargo at the docks of the company in the inner harbor of the port of Baltimore. She had no steam up and was pulled out of her berth by the company's tug, Venus, to be towed to another wharf, where the remainder of the cargo was to be unloaded. The Miller was about 300 ft. from the wharf, when the Bowden, coming up the harbor, sighted her, and at a distance of about 1,200 ft. blew a blast, indicating that she would pass between the Miller and the wharf. The Miller did not respond, nor did the tug, which was hid from the view of the Bowden behind the hull of the Miller. Getting no response, the Bowden kept on her way, without slackening or stopping, until she was within 300 ft. of the Miller, when, observing that the Miller was gradually approaching her, the Bowden put her helm over and reversed at full speed. She steered badly, however, and did not respond readily to her engines. Consequently, her momentum was not checked, nor her direction changed when she crashed into the port side of the Miller, tearing a hole 12 ft. from top to bottom and about 3 ft. wide. The Miller was towed to her wharf and there sank.

At the time of the collision the Miller was moving under the influence of a breeze, and the momentum acquired by the previous pull of the tug. There was no tide. The lower Court had decided that there had been room enough for the Bowden to pass between the Miller and the wharf, but the pilot of the Bowden had gone too near the Miller, relying upon her to get out of the way. That he thus lost his head, and, too late, found the Bowden unmanageable. The Court of Appeals agreed with this view, holding that it was not a case of "inevitable accident," or a collision which had occurred while both parties used proper care and nautical skill. When the Bowden received no response to her signal whistle, her attention should have been arrested, and she should have taken precautions to avoid the result of negligence, even on the part of the Miller. This she failed to do. Turning to a consideration of the culpability of the Miller, the Court held that though she had the right to the position she occupied at the time of the collision, yet having regard to the narrowness of the channel and her helpless condition, she should have taken extra precautions. As a fact, her master and crew were busily occupied in duties other than those of navigation; as if she was tied up to a wharf. They did not even hear the whistle of the Bowden. True, her master could not have responded with signals indicating a course, as her engines were not going, but he could have blown danger signals, or have caused the tug to signal, or tow her out of the way. It was "manifest that the indifference and negligence" of the crew of the Miller contributed to the accident. Consequently she was also in fault, and the court found, under the circumstances, that the damages should have been apportioned. The case was accordingly remanded with instructions.

Circuit Judge Simonton, Circuit Court of Appeals, Fourth Circuit. Attorneys, Robert H. Smith for appellant and William Pinkney Whyte for appellees.

U. S. DISTRICT COURT.

Stowaway Seeks Damages For Assault.

The means for redress for a stowaway, who had been assaulted, were defined in this case. A. A. Holmes had libeled the steamship Miami to recover damages, on account of personal violence inflicted upon him by the master. The Court decided against the libelant, holding that it was a case of assault and battery, and consequently the civil proceeding against the vessel could not be maintained. Though the act complained of had happened on board the vessel, it could not be held that there was any breach of any maritime duty, or obligation, on the part of the master of the vessel. The libelant was not rightfully on the vessel. He had come aboard clandestinely and hid away, without the consent or knowledge of the master; consequently he was a trespasser. There was no contract between any one representing the vessel and the libelant, and there was no "duty" to him, on the part of the officers and crew. This the Court explained as meaning "maritime duty." There was a duty on the part of the master not to injure or cruelly treat the libelant, a duty not to allow him to die or suffer from starvation, if the master was able to relieve him. This duty, however, rested upon the principles of common humanity, and in no way arose from his duties or obligations as master of the vessel. Though the facts showed the master had "intentionally inflicted unlawful violence" upon the libelant, the Court had no jurisdiction.

District Judge Toulmin, District Court, S. D. Alabama. Attorneys, Smith and Gaynor, for libelant; Pillans, Torrey and Hanaw for the Miami.

Various Claims Growing Out of a Collision.

An interesting decision, covering several points in dispute, was given in the case of the British ship Bedfordshire against the Glencairn, to recover damages for collision in the harbor at Astoria, Oregon. The bill presented by the libelants included these items:

Necessary repairs to the Bedfordshire, and commissions thereon	$3,126.25
Loss of the use of the ship during the time required for repairs	3,650.00
Depreciation of market rates for ship of the class of the Bedfordshire in the meantime	1,618.20
Loss of time, and expenses of master and crew, and the wages thereof	800.00
Injury to the Bedfordshire by reason of the strain suffered, and other and additional losses incident to and resulting from the collision	600.00
	$9,794.45

The owners of the Glencairn admitted their liability, but calculated the damages at $2,299.50, which they deposited in court.

The collision occurred while the Bedfordshire was at anchor. The Glencairn was towed to a nearby anchorage, but her anchor was dropped so close to the Bedfordshire that when she swung around the vessels came in contact. In court, the captain of the Bedfordshire testified there was an agreement to arbitrate, but this the captain of the Glencairn denied, asserting that a third party, Captain Pope, had been called in only to decide whether certain damages had occurred at the time of the collision or before. Captain Pope had decided in favor of the Bedfordshire.

On this point the Court held, though there was no disagreement between the masters as to the understanding, in pursuance of which Captain Pope acted, there was a disagreement as to the effect of the understanding. The agreement to arbitrate should have been certain, and not left to implication, and besides, there were other matters in dispute to which the agreement did not refer. The Court would not allow the claim for damages based on a decline in charter rates, while the Bedfordshire was undergoing repairs. Evidence showed that the Bedfordshire had been in the harbor nearly a month before the collision, and

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had declined offers for her charter as high as 35 shillings. In the opinion of the Court she was not entitled to recover from the Glencairn the value of the market which she refused.

Considering the claim for commissions on money disbursed in repairs, the Court held, though the allowance might be customary, and had even been admitted in a case cited, in which such a claim was not contested, yet, he was not prepared to recognize such a custom among shippers as establishing a rule of damages in cases of maritime collision. The Court also declined to allow a claim for money to be paid a third person for superintending the repairs to the damaged vessel. This was for $125. In the Court's opinion there was no reason shown why the master could not have superintended the repairs himself. In fact, he was actually present during the whole period, and there was no more fit or proper person for superintending repairs than the master. Other claims were disallowed on purely legal grounds. Subsequent to the filing of this opinion the attorneys for the parties in court agreed that certain additional items, amounting to $340.15, should be paid by the owners of the Glencairn. This the Court included in the decree. He, however, gave the Glencairn's owners their costs, holding, under the rule that courts should facilitate amicable settlements, that they were entitled to it, having made reasonable offers of settlement and paid into court an amount equal to the award of the Court.

Judge Bellinger, District Court, D. Oregon. Attorneys, F. D. Chamberlain and Zera Snow for libelant. C. E. S. Wood and J. C. Flanders for claimant.

NEW PUBLICATIONS.

FUEL AND REFRACTORY MATERIALS. By A. Humbolt Sexton, F. I. C., F. C. S., Professor of Metallurgy in the Glasgow and West of Scotland Technical College; President of the West of Scotland Iron and Steel Institute, etc. London, Blackie & Son., Ltd.; New York, D. Van Nostrand Company. First edition, pp. 343. Illustrated. Price, $2.00.

In his preface to this book, the author explains that it is intended to occupy a place between the extensive treatises on the subject, and the brief material which is to be found in works on metallurgy. The conciseness with which the subject is treated—yet in a comprehensive way—is one of the chief merits of the book. It does not occupy much space and yet within its pages can be found information of an accurate scientific character about this important subject. While it is thus a work of importance, it is worded and illustrated in a manner which should make the contents plain to the intelligent student. From the very nature of it, however, it is not a book which is absolutely essential to the marine engineer, but it is one of those books which would round out a man's knowledge of the properties of fuel, and would direct his attention to still further advanced study, in various practical directions. Looking at the book from a marine standpoint it is a pity that the subject of liquid fuel is not more exhaustively treated, having been given only six pages. This perhaps is accounted for by the associations of the author, for there is a superabundance of space devoted to metallurgical processes. It is one of those convenient books, however, which for the purposes of the practical engineer give a ready means of references on the subject treated.

CATALOGUES.

An album of designs has been issued by Fred W. Martin, Racine, Wis., containing sixty-five or more full-page pictures of various types of boats, with details of design and construction. The little book is very interesting, and to those who seek information about yacht and canoe building it will prove valuable and fully worth the 50 cents charged.

The eleventh annual catalogue of the Pullman Sash Balance Co., Rochester, N. Y., is just at hand. This catalogue describes and illustrates every conceivable kind of sash balance, including quite a number of styles designed especially for use at sea. These are made of aluminum, bronze or other metal so that they shall not be affected by salt water or atmosphere. Ship builders and repairing concerns will find one of these catalogues very valuable for reference.

A very handsome catalogue was published by the Buffalo Forge Co., Buffalo, N. Y., some time ago. It is an octavo volume, very elaborately illustrated. It describes in full detail the various manufactures of this company for ventilating and heating, also forges and engines. So great was the demand for this book that another edition of several thousand copies of somewhat smaller and more compact size is about to be issued. Marine men who wish to read upon the ventilation of vessels, forging outfits for marine use, and other kindred subjects should have one of these new catalogues.

Probably the largest stock and assortment of marine, draughting and mathematical instruments in the country is illustrated in the catalogue of the Keuffel & Esser Co., 127 Fulton street, New York. They include calculators, rules, ship curves, spline weights and sets of splines, sextants, octants, sun dials, compasses of all kinds, barometers, marine glasses in great variety, and, in short, everything that a marine man might need to use in his work, whether he be on shore duty or on board ship. This company is just about to publish a new edition, which will be sent to readers of Marine Engineering upon application, illustrating and describing fully all of these instruments.

BUSINESS NOTES.

A GOOD REPAIR JOB.—Ross Iron Works, at the docks foot of Twenty-sixth street, Brooklyn, N. Y., have just completed repairing the steamer Queen Adelaide, which brought a cargo of sugar to Philadelphia from Batavia. The machinery was given a thorough overhauling, shafting being removed and trued up, and new bearings fitted, etc.

THE U. S. MINERAL WOOL CO.—2 Cortlandt street, New York, has had a steadily increasing demand for its corrugated copper gaskets since the increased use of high pressures. This gasket may be used in place of rubber or other materials in general use for packing. It consists of thin sheet copper, stamped with concentric corrugations. Three to six corrugations are all that are necessary, so that the space within the bolt holes usually determines the width of the gasket. In cases where the flanges are thin, and for this reason liable to bend when the bolts are tightened, it is advisable to extend the copper gasket to the full width of flange. This will, of course, require the cutting of bolt holes in the gasket. Connections made with these gaskets will not blow out after continued use, for each corrugation makes the entire circle of the flange, and so long as the contact is kept complete by compression the joint cannot leak. They may be put in place while steam is leaking through a valve.

VENTILATION ON BOARD SHIP.—It is only comparatively recently that mechanical ventilation has received much attention from ship designers. It is desirable, as a rule, that ventilation should be carried out without the use of cumbrous apparatus, and for this reason electric motors are being largely used for driving ventilating fans and blowers. A combination of this sort is manufactured by the Interior Conduit & Installation Co., 527 West 14th street, New York. These can be used in any part of the ship in which a supply of air can be obtained, and an outlet found to get rid of the foul air. As heat will always ascend to the top of the room the plan usually adopted is to supply cool fresh air at a point near the bottom, and exhaust near the top. With the use of this particular apparatus it is claimed that the temperature of any engine room can be maintained within at least ten degrees of the outside temperature. A fan house is located on the upper deck with ventilating ducts to the engine room. The apertures should be the right proportion so that the cubic contents of the room ventilated can be changed from one to five times a minute. The amount of air can of course be controlled by the speed of the motor. This company gladly furnishes details of the apparatus implied.

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